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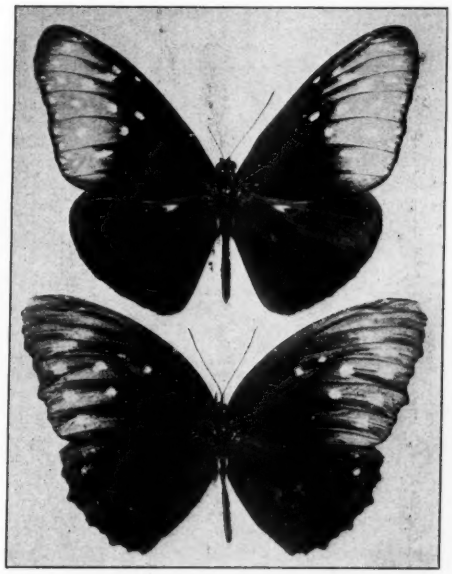
Dimorphic Mimicry among Butterflies.

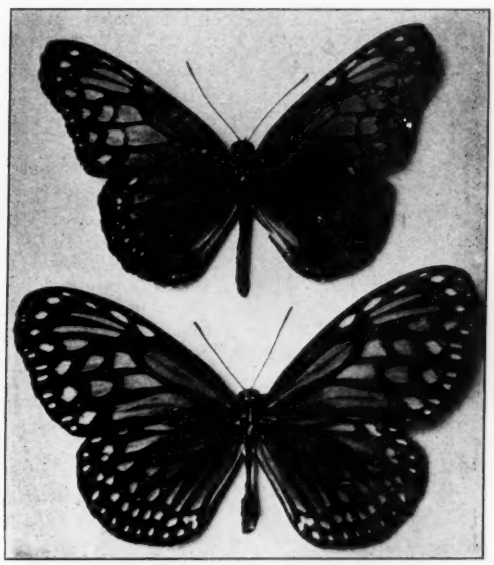
PERHAPS the most striking instances of true mimicry are those which may be described as dimorphic. Not infrequently, but for reasons which are generally very obscure, the sexes of a butterfly differ so widely in colours and markings that the casual observer would certainly take them for representatives of distinct



Euplœa linnei ♂. *Elymnias leucocyma* ♂. **Ex Assam.**

species. And when such a difference exists between the male and female of a well-protected butterfly which is a prototype for mimicry the male and female of the mimicking species are sometimes seen to have each followed out, almost line for line, the colour characteristics distinguishing the sexes of the distasteful insect. This is well shown in the case of *Euplœa linnei* and *Elymnias leucocyma* from Assam. The males of both these species have shining blue fore-wings, spotted with white; the fore-wings of the females have a circumscribed blue area, spotted with white, while

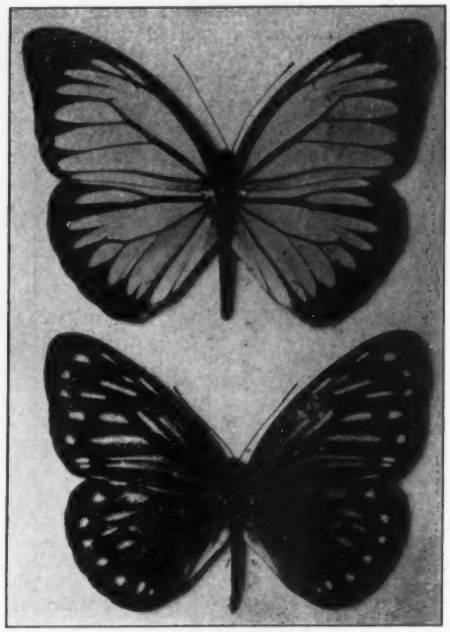
Euplœa linnei ♀. *Elymnias leucocyma* ♀. **Ex Assam.**



Bahora aspasia ♂ **and** ♀. **Ex Sumatra.**

their hind wings are brown with pale stripes. Yet the species belong to entirely different groups, and are related by no closer bond than that of mimicry. The *Euplœa* is the evil-tasting prototype. The *Elymnias* belongs to a group of poorly-protected butterflies allied to the *Satyridæ*, or "Browns."

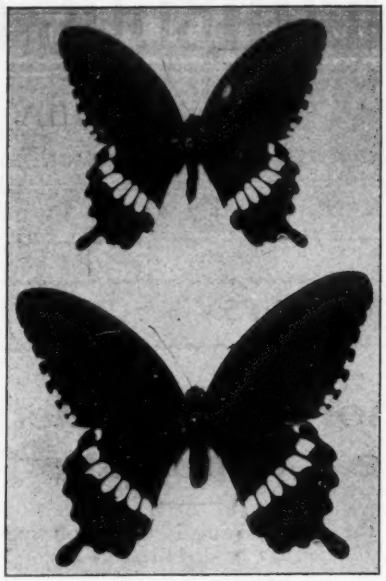
Again, instances occur in which the female of a species is mimetic, while the male is either non-mimetic or else resembles a prototype quite distinct from that followed by its mate. In the case of *Eronia valleria* (from Sumatra, Borneo, etc.), the male may, perhaps, be regarded as an imperfect mimic of the striped species, a *Danais*, so common in these islands. The female is a very close mimic of *Bahora aspasia*, from



Eronia valleria ♂ **and** ♀. **Ex Sumatra. (Compare female with that of** *B. aspasia.*)

the female of which the inexperienced observer would be unable to separate it.

Sometimes a single species has two or more distinct forms of the female, each of which is coloured in mimicry of a separate evil-tasting species. In illustration of this, the case of *Papilio pammon*, a species having a wide range in the East, may be cited. The male of this butterfly is black, the fore-wings having a marginal row of white spots; the hind wings having a curved, transverse band of white, divided into spots by the nervures. There is a form of female almost exactly like the male, but it is somewhat rare. The common forms of female are entirely dissimilar to their mates, and were described as different species by the old naturalists. That which was called *P. polytes* has a large white spot, broken by nervures, in the middle of each hind wing, and a row of large red marginal spots. The dark brown fore-wings are striped with a pale colour. The other common form of *P. pammon* female, described originally as *P. romulus*, has extensive red markings on the hind wings, and no white spot. Its fore-wings are crossed with two broken bands of white.



Papilio pammon ♂ **and** ♀ **(form like** ♂**).**

These two forms of female mimic respectively two distinct species of butterfly, belonging to another

Papilio aristolache. Papilio pammon ♀ (*polytes* **form**).

section of the great *Papilio* genus, which appear to be well-protected insects. The *polytes* variety of *P. pammon*

is curiously like *P. aristolache;* the *romulus* form is an equally close mimic of *P. hector*.

These wide differences existing between the sexes of a mimicking species seem at first very difficult to understand. It has been suggested that the males, for some reason, are better able to protect themselves than are the females, and do not, therefore, need the protection of a mimetic likeness to a warningly coloured type. In some cases the males certainly seem stronger on the wing, and better able to escape from danger by flight; while it is obvious that the females, when depositing their eggs upon vegetation, would run more risk of being attacked by birds and other insectivorous creatures than their mates, who are free from preoccupations likely to detract from their alertness.

The question as to how such wide differences between the sexes of one species came to be seems, at first, a very perplexing one, especially in cases where two or more mimicking varieties of the female exist. We know that living creatures often exhibit a strong tendency to vary, but these several well-marked forms of one species seem to be something more than the outcome of mere "sports."

It is possible—at least, in some degree—to show how they have been produced and established. There are two common butterflies of the family *Nymphalidæ*, known respectively as *Hypolimnas misippus* and *H. bolina*. These species have their headquarters in India, but they have a wide range in the Eastern Hemisphere. They are closely related, and the males are very similar—both having blackish wings, with

Papilio hector. Papilio pammon ♀ (*romulus* **form**).

central areas of white beautifully tinted with shining purple. The females of both species are curiously variable, and are well worth a careful study by those seeking to comprehend the theory of mimicry. Taking first *H. misippus*, we find that no female at all like the male in appearance is known to exist. The common form of female is that shown in the accompanying photograph. It is bright tawny, bordered with black, and has a conspicuous band of white in the fore-wing. In this it is seen to be a wonderfully accurate copy of

Danais chrysippus. Hypolimnas misippus ♀. *Hypolimnas misippus* ♂.

that common and much-mimicked Eastern butterfly, *Danais chrysippus*. This insect (*D. chrysippus*) is common all over Africa and Southern Asia, and there are a number of closely allied forms—whether constant local varieties or actual species is not definitely known. These forms vary a good deal in colour and marking. For instance, in *D. alcippus* the hind wings are almost entirely white; in *D. klugi*, all the wings are tawny, with black edges, and there are no white bands in the fore-wings. The range of *H. misippus* is very similar to that of *D. chrysippus* and its several forms, and wherever a marked difference is seen in the appearance of the latter, it is found to be reproduced upon the wings of the mimicking females of the former, usually in a strikingly close manner. But though the females vary in different districts, the colouring of the males is identical in each locality.

These facts—the extraordinary difference between the sexes, the various forms of the female, none of which are in the least like the males—are very surprising; but in the case of the allied *H. bolina* we find, in measure, a key to the mystery. The females of this butterfly vary in a much more erratic manner than do those of *H. misippus*, albeit none of them has attained to such striking mimicry. There is a form (shown in the accompanying photograph) which is an imperfect mimic of the common evil-tasting butterfly, *Euploea core;* there are also dozens of other forms, all exhibiting some marked difference, but few showing any tendency towards a mimetic likeness. The group of

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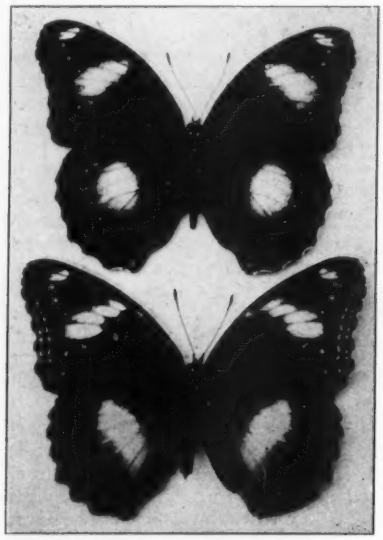
females showing the gradual growth of the tawny colour, however, is interesting. The colour (which is quite unknown on the wings of the male) makes its

Euplœa core. *Hypolimnas bolina* ♀. *Hypolimnas bolina* ♂.

appearance as a small spot, and may be traced from one specimen to another until it is seen to form a large suffusion in the wing-area. Such specimens go far to

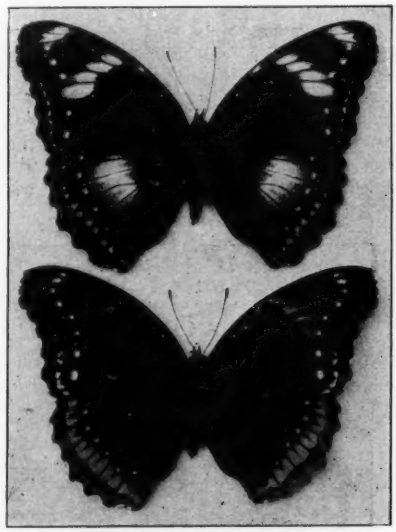


Hypolimnas bolina ♀ s. **(Upper one like male.)**

bridge over the gap between the *H. misippus* male and its perfectly mimetic, tawny females; for these tawny blotched females of *H. bolina* seem to show a definite variation in the direction of the *Danais chrysippus* prototype. It is conceivable that eventually, through the agency of natural selection, this dawning mimetic likeness may be perfected and established, as it appears to have been in the case of *H. misippus*.

It is impossible to suggest a reason to account for the different courses of natural selection in the case of species so closely related. The fact remains, however, that whereas the colour specialisation of *H. misippus* appears to be fairly complete, that of *H. bolina* is still in an elementary stage. The females of *H. misippus* differ both from the male form and from one another, but always in the direction of some well-protected prototype; moreover, there are no intermediate forms. The females of *H. bolina*, on the other hand, vary from specimens that are almost like the males through an extensive range of closely connected forms, very few of which approach any existing warningly-coloured prototype.

Although the mimicking *Hypolimnas* butterflies are often instanced as cases of true or Batesian mimicry, some authors consider them to be typical of what is known as Müllerian mimicry, in which both the type



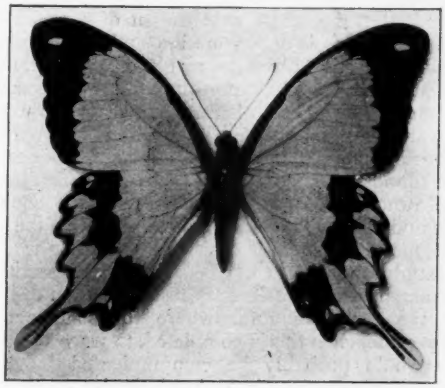
Hypolimnas bolina ♀ s.

and the copy are well-protected insects, deriving enhanced benefit from their mutual likeness. The theory of convergent mimicry, as suggested by Professor Müller, will be described in a subsequent article. But the question as to which section of mimicry the *Hypolimnas* butterflies rightly belong in no way affects the interest attached to their colour development as described above.

An instance of the manner in which butterflies belonging to widely distinct families develop a close external likeness one to the other, because of their mimicry of a common distasteful type, is seen in the annexed photographs. The prototype is *Amauris dominicanus* from South Africa. This is mimicked by one form of *Papilio cenea* female, which, it is seen, differs from the male not only in colour and marking, but also in the complete loss of the long "tails" of the hind wings. Then the Nymphaline butterfly, *Euralia* (*Hypolimnas*) *anthedon*, in both sexes, is a very perfect mimic of the *Amauris*.

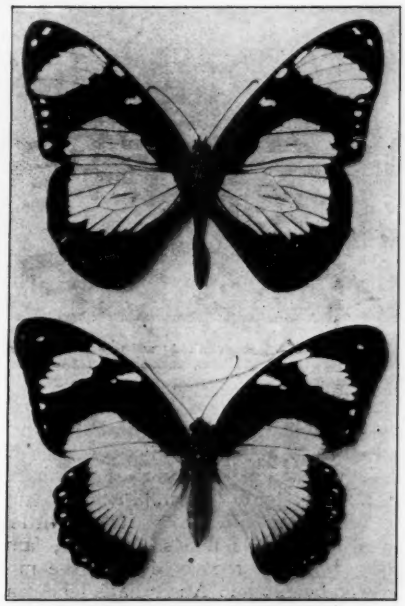
There is also, in Cape Colony, another form of *Papilio cenea* female, which is a striking mimic of

another butterfly of the evil-tasting group (*Amauris echeria*), which is black blotches and spotted with rather dusky yellow. This form is very like another species



Papil o cenea ♂. **Ex S. Africa.**

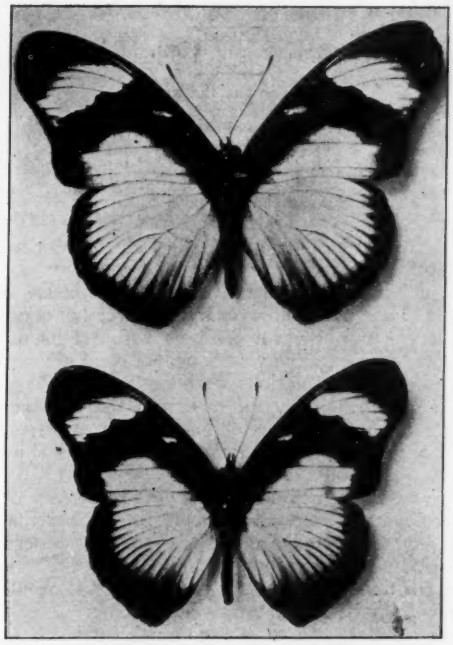
of *Euralia*, which also mimics the *A. echeria*. Finally, there is a third form of *P. cenea* female, tawny in colour, marked in black and white in imitation of *Danais chrysippus;* and, as we have seen, the females of *Hypolimnas misippus* are very perfect mimics of the same species.



Amauris dominicanus. Papilio cenea ♀. **Ex S. Africa**

In regard to the multi-form females of *Papilio cenea*, it should be pointed out that there exist in Madagascar and Abyssinia closely allied species, the females of which differ very little from the males. Not only have they the same pale yellow and black colouring, but the hind wings preserve the characteristic tails. There is, however, a prominent black bar on the costal margin of the female fore-wing; and it is presumed that this represents the commencement of the darkening, which, in the case of the allied mimetic females, has suffused so large a portion of the wing area.

The question as to why the females of species closely related to others which are very perfect mimics should have retained their ancestral form is difficult to answer



Euralia anthedon ♂ **and** ♀. **Ex S. Africa.**

satisfactorily. In the absence of contradictory evidence, however, it is quite admissible to assume that the life histories of these non-mimetic species have been fraught with less hardship and persecution than fell to the lot of those which have gained the protection of mimicry. In the case of *Papilio meriones*, this view is certainly plausible, and is adopted by Professor Poulton. "It requires a very slight exercise of the imagination," he says, "to picture the steps by which these marvellous changes have been produced; for here the new forms have arisen at so recent a date that many of the intermediate stages can still be seen, while the parent form has been preserved unchanged in a friendly land, where the keen struggle of continental areas is unknown."

The Fourth International Ornithological Congress.

THE Fourth International Congress of Ornithologists will be held, as arranged at the previous meeting at Paris in 1900, in London this year, under the presidency of Dr. R. Bowdler Sharpe, the head of the Ornithological Department of the British Museum. It will assemble at the Imperial Institute, South Kensington, on Monday, June 12, and sit until the end of the week, during which, besides the ordinary business, it is proposed that evening meetings and short excursions shall take place. Longer excursions will be made after the close of the meeting. An Organizing Committee has been formed to make the necessary arrangements.

The Secretaries to the Congress will be Dr. Ernest Hartert, of the Zoological Museum, Tring, and Mr. J. L. Bonhote, of Ditton Hall, Cambridgeshire, to whom communications may be addressed. The Treasurer will be Mr. C. E. Fagan, of the Natural History Museum, South Kensington. It is hoped and expected that many of the leading ornithologists from all parts of the world will attend the Congress.

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Our Sun and "Weather."

By WILLIAM J. S. LOCKYER, M.A., Ph.D.

"The moon and the weather
May change together;
But change of the moon
Does not change the weather.
If we'd no moon at all,
And that may seem strange,
We still should have weather
That's subject to change."—*Notes and Queries.*

THERE are many of us who would like to know whether our next summer will be sunny and warm or our next winter dry and cold, so that we might prepare for the delights that could be enjoyed by such weather conditions. That day is not however with us yet, and its delay in coming is owing to many reasons, the chief among which being that civilized nations were not so widely scattered over the earth as they are now, and that consequently meteorological records extending over a long period of time do not exist in sufficient number to allow of a complete discussion being made.

If we only had behind us one hundred years of good meteorological observations made in the way that they are to-day, and also an unbroken record of observations of sun-spots and prominences, then we should be in a far better position to tackle such meteorological problems as are now lying before us unsolved.

Unfortunately one cannot go much further back than about fifty years when discussing the great majority of meteorological observations, for in many cases they are either very sparse and broken, or it is not known with what degree of accuracy they were made. In the case of solar phenomena the investigator is still more restricted; for, although the observations of sun-spots have been made in a more or less crude manner for a great number of years, it was not till about the year 1830 that a systematic method of observation was adopted; further, the solar prominences, important indicators of the sun's activity, were only first recorded systematically in the year 1872. The reader will therefore understand that before all these different phenomena can be correlated to enable long-period forecasts to be successfully made, a greater period of time than the one at present available is absolutely necessary.

This is, however, no reason why attempts should not now be made to find out whether these solar and terrestrial changes are related to each other, and if possible to point out how, from our present material, such a relationship, if detected, can assist us in making at any rate rough forecasts of approaching seasons.

It is generally acknowledged that we are children of the sun, and life on this earth is only possible in consequence of his presence. Our sun is, so to speak, the fuel on which we are all dependent, and it is, therefore, quite natural to look to him as the instigator of our "weather." Now, our orange-shaped globe is surrounded by the atmosphere. The sun from without pours his rays down on the earth's surface and heats it, whether it be water or land; this heated land or water warms the atmosphere in contact with it, and this warmed air, which is now lighter than it was before, rises from the surface and is replaced by the cooler and heavier air flowing in at the bottom. In this way a current of air, a wind, is set up. The land or water most heated in this manner is that which lies in those regions over which the sun during a year passes overhead, and the reader will at once gather that this part of the world is that which includes the equatorial regions. It is due to the heating of this region, coupled with the great cooling about the terrestrial poles in consequence of the presence of ice and snow, that the whole mechanism of the circulation of the atmosphere is set in motion and maintained, and "weather" is the ultimate result of this circulation. Fortunately for us—but unfortunately for meteorologists—the surface of the earth is not completely covered over with water, but is studded here and there with great stretches of land, so that an unequal heating of the atmosphere round the equator takes place, and the directions of the atmospheric currents the further the equator is left behind, combined with the rotation of the earth, become more complicated than they otherwise would be.

To study the action of the sun on the earth to its fullest extent it is therefore best to begin in the region about the earth's equator where the solar action is greatest; and when this is completed, to trace this action, which would probably be communicated by the air currents, to the regions in higher latitudes.

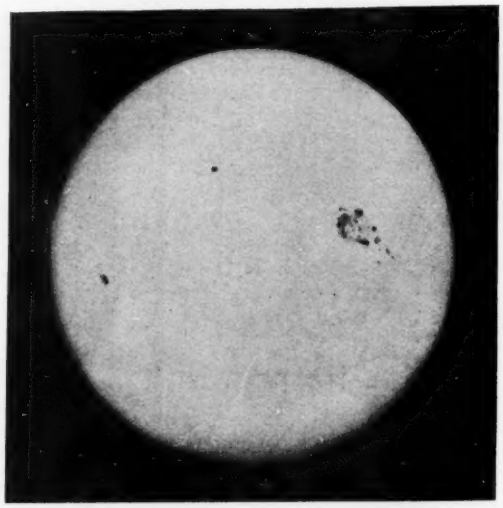

Fig. 1.—The Sun, as photographed with an ordinary telescope, showing the spots on his disc, taken about the time of sunspot maximum.

It is well known not only in these but in all other latitudes that the "weather" is not the same every year. Sometimes there is a great abundance of rain, sometimes very little; one winter is very mild while another is very cold. In fact each continent has its own little meteorological worries such as floods, droughts, famines, &c. Thus India has just recovered from the most severe famine ever known, while Australia is labouring from a similar visitation. There seems little doubt that all these conditions are produced by changes in intensity or direction, or both, of the main currents in our atmosphere, and since these conditions depend for the main part on the distribution of atmospheric pressure, it is this element which should receive the closest attention.

It has been stated above that the most likely cause of these variations finds its origin in the sun, for, granting a change in his heating powers, the strength of the atmospheric currents, and consequently the atmospheric pressure, would be accordingly altered.

The question therefore arises, Does the heating power of the sun vary? This is difficult to answer directly, although from certain observations of his surface, to which

reference will now be made, the deduction is that great heat variations do occur.

If the sun's disc be scanned from time to time, it will be found that sometimes there are spots and sometimes there are none (fig. 1). According to our present knowledge these spots are produced by the descent of comparatively cool matter from the higher reaches of the solar atmosphere, so that the more spots

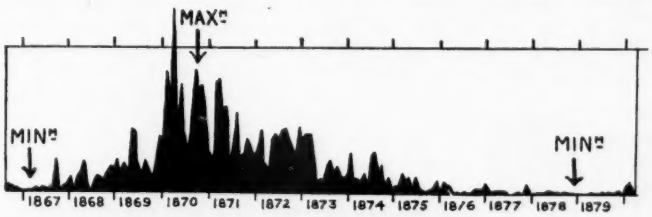

Fig. 2.—The dark portion shows the variation in the amount of the total spot area on the Sun from year to year for an eleven-year period. Notice the three prominent outbursts in the years 1870 and 1871.

there are, the greater the quantity of matter descending. Since this falling material is the result of previous uprushes of highly heated matter from the lower levels of the sun's atmosphere, it stands to reason that this spot phenomenon indicates great solar atmospheric disturbance and therefore greater activity and consequently more intense heating capacity. Thus we arrive at the conclusion that the greater the number of spots, the greater the solar activity and therefore the hotter the sun.

Now there is a decided periodicity in spot activity. For some years only a few spots become visible, while a little later they become more numerous until a maximum is reached, after which they begin to dwindle again in numbers until the succeeding minimum is attained when the sun remains spotless for months together. The accompanying diagram (fig. 2) will give the reader a good idea of this variation. The dark portion, which looks like a silhouette of a cathedral city, shows the change of the amount of "spottedness" of the sun for each solar rotation from the year 1867 to 1879; the arrows indicate the "epochs" or times, as determined from a curve specially smoothed for this purpose, when there are fewest (minimum) or most (maximum) spots. It will be noticed that there is not a gradual increase of spotted area,

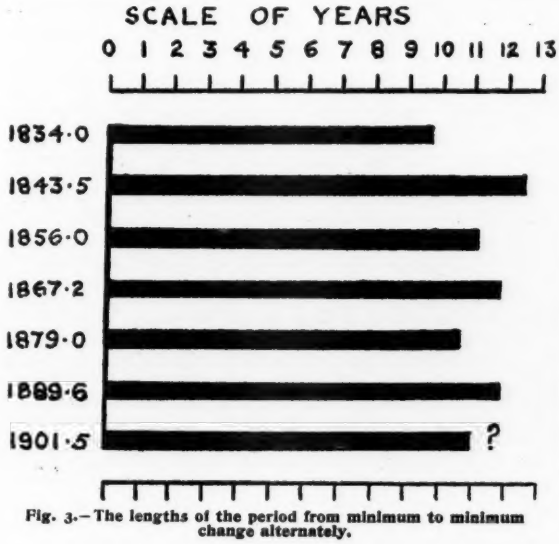

Fig. 3.—The lengths of the period from minimum to minimum change alternately.

but that, as the diagram shows, there seem to be intermittent outbursts. From this figure, which includes a whole sunspot cycle, it will be seen that the time from one minimum to the next is about twelve years; this, however, is not always the case. A glance at the next diagram (fig. 3) shows that since 1834 the lengths of these periods are alternately longer and shorter than the preceding one, the mean length being a little more than eleven years. It will thus be seen that the so-called "eleven year cycle" of sunspots is only *approximately* true. A reference again to figure 2 shows further that the epoch of maximum occurs nearer the preceding than the following minimum; this is always the case, only from one period to another this interval from minimum to maximum is not the same. To illustrate this, these intervals are arranged in figure 4 one below the other, and instead of an alternate change in length they recur every third period. Thus if this apparent law holds good the approaching maximum will occur about a little more than three years after the last minimum (this occurred in about the middle of 1901), that is about the end of the present year (1904). Another curious fact relating to the sun-spot cycle is that when the interval from minimum to maximum is shortest, the total amount of "spottedness" included in the whole period from minimum to minimum is greatest. This is graphically shown in the accompanying diagram (fig. 5). The last

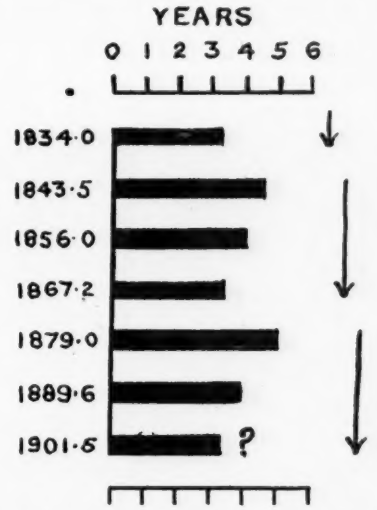

Fig. 4.—Diagram to show that the interval between a minimum and the following maximum changes in a cycle of about 35 years.

square represents the relative spotted area that may be expected for the present cycle if the previous conditions be repeated.

The above brief summary of the sun-spot variations tells us that not only does the heat of the sun change, but that these changes occur in cycles of about eleven and thirty-five years. There is, further, another cycle, not very well indicated, which has a period of less than eleven years, probably the same as that which is more clearly defined by the solar prominence observations to which reference will now be made.

The solar activity can also be gauged from "prominence" records. These disturbances are probably of more consequence than those of spots. The latter are strictly limited as regards position on the sun's surface

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to a comparatively narrow zone near each side of the solar equator, while there seems no such restriction to the former. Again, if the relation between the areas of spots and prominences be considered, those of the former are practically insignificant. A study of prominences is therefore of the highest importance when the activity of the solar atmosphere is in question, but, unfortunately, records of these only commence in the year 1870. Unlike spots, which, as previously pointed out, are the result of the descent of comparatively cool matter from the upper regions of the solar atmosphere, prominences consist of ascending currents of highly-heated matter from the lower

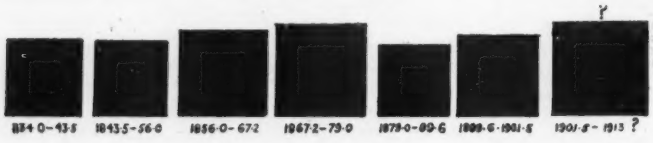


Fig. 5.—If the areas of all the sunspots which appear on the Sun's disc from one minimum to the next be added together, then the above squares show the relative change of spotted area for each of the periods from the year 1834.

to the higher layers; indeed, they are the precursors of spots and are thus more direct indications of solar disturbances. That they are very important factors in solar "weather" can be gathered from their enormous magnitudes, some of them being 100,000 miles or more in height and correspondingly broad.

Prominences, like spots, have periods of maximum and minimum frequency. As a rule, when there are few spots there are few prominences, and when the spotted area is large so is that of the prominences. There is thus a very close connection between these two

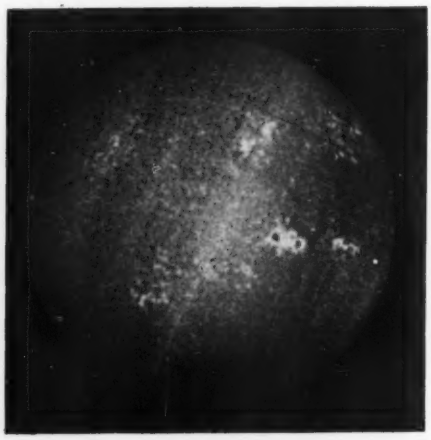


Fig. 6.— A picture of the Sun taken in light of one colour, showing that there are other areas on the solar disc which are more extensive than those of spots. The former appear bright while the latter are dark.

phenomena; but it must be stated that this connection only holds good when the prominences situated nearest the equatorial regions of the sun are alone taken into consideration. It is due, however, to the fact that prominences are at times very numerous near the solar poles that the curve representing the mean variation of their frequency from year to year does not rise or fall gradually throughout a cycle, but is of a wavy nature, as can be seen by a glance at the curve shown in a subsequent figure (fig. 7). It is this peculiarity that makes the prominence curve so important, for these "humps" on the main curve represent solar changes of activity that are scarcely traceable on the spot curve. There seems reason to believe, therefore, that the observations of prominences are capable of giving us far more information regarding the circulation and activity of the solar atmosphere than those of spots.

We thus see then that the study of spots and prominences has made us acquainted with three different periods of solar changes. Thus we have a short period of a little less than four years, another cycle covering in the mean a little more than eleven years, while a third variation occupies about thirty-five years.

Having thus briefly summarised the chief facts concerning the various changes of solar activity, attention will now be paid to the records of meteorological phenomena to see if any trace can be found corresponding to these solar variations. The question now arises as to which meteorological element should be chosen to commence operations with. For several reasons, which need not be mentioned here, barometric observations have been selected, for they supply us with an excellent means of detecting variations of pressure which are direct indicators of air movements towards or away from the earth's surface. Greater solar radiation means greater heating power, and therefore stronger ascending currents away from the earth in some parts of the world, and consequently greater descending currents in other parts; thus we should expect to find lower and higher pressures simultaneously in different regions of the earth's surface.

A decided great advantage in employing barometric records is that the variations of this element from year to year are very similar over large areas, and do not change according to local conditions as is the case with rainfall. Thus, to take the case of the British Isles, for example, the pressure variation of, say, Oxford is quite sufficient to illustrate the variation over the whole of the British Isles, as if we employed the records of Valencia, Aberdeen, Greenwich, or Edinburgh, which are all quite similar. Rainfall is the *effect* and not the cause of barometric pressure variations, and we in these islands are quite familiar with this fact. A fall in the barometer with us generally means rain, and a rise probably dry weather. Rainfall then being an after-effect of pressure, any variation of the latter should have a very close connection with the former.

(To be continued.)

Messrs. Adolph's Selenium Cells.

We have received from Messrs. Adolph, of Farringdon Road, a catalogue of their selenium cells; and selenium cell apparatus. The great interest of selenium to the electrician lies, as everybody knows, in the alteration which becomes apparent in the electro-conductivity of this element as the light thrown on it varies. The relation between the change of electric resistance and the amount of illumination has been expressed mathematically; and if selenium could always be depended on to behave with perfect regularity, some of the practical uses to which it could be put might effect astounding revolutions in light telephony. Herr Ruhmer, in Berlin, has endeavoured to transmit sounds along beams of light by the employment of selenium cells, and within certain limits the experiments have been successful. What is wanted most, however, with regard to selenium, is new and continued experiment; and the opportunity which Messrs. Adolph afford of bringing within the reach of laboratory students selenium cells of all kinds, as well as apparatus for testing its properties in light telephony, and its applications to other branches of research, is one that we warmly welcome.

Electrotyping.

By DR. F. MOLLWO PERKIN.

No one has been long in a chemical laboratory without having learnt that one of the simplest tests to ascertain whether a solution contains copper is to place the blade of a pen-knife into it. If copper is present the blade of the knife becomes covered with a thin coating of copper. Other metals besides copper can be plated out upon another metal by simply immersing it in their solutions. For example, if a silver article is dipped into a solution containing a gold salt, it will become covered with a thin coating of gold. This process of dipping is to a certain extent actually performed in practice, hence one is accustomed to talk of giving an article a gold wash. For example, at one time the method employed for gilding the inside of silver boxes, the bowls of spoons, &c., was to wash them over with a piece of rag which had been dipped in the gold solution. When a metal is plated by simply immersing it in the solution of the other metal, then an equivalent of the metal which is being plated upon it goes into solution. Thus, when the blade of a knife is placed into a solution of a copper salt and becomes superficially coated with copper, it is only done at the expense of a portion of the blade which goes into solution. Supposing the solution to consist of copper sulphate, then as copper is deposited out, sulphate of iron takes its place. Thus we can write it in the form of an equation :

Copper sulphate + iron = iron sulphate + copper

or by using symbols

$$CuSC_4 + Fe = FeSC_4 + Cu.$$

The metal which goes into solution and upon which the other metal becomes plated out is said to be electropositive to the metal in solution. Zinc is the most electropositive of all metals, and under appropriate conditions is able to replace all other metals from the solutions of their salts.

Now this method of plating or depositing out a metal has only a very limited application. It is used to a certain extent in gold plating, but not for depositing such a metal as copper. The methods employed are electrolytic. It is found if an electric current is passed through a solution of a metallic salt, *e.g.*, copper sulphate, that the copper is deposited out upon the one electrode,* and at the other electrode if it is of an insoluble material, such as platinum or graphite, oxygen gas is evolved. The pole at which the metal is deposited is called the negative pole or cathode, the one at which oxygen gas is evolved, the positive pole or anode. Fig. 1 shows such a cell diagramatically. A is the negative electrode or cathode (—) and B is the positive electrode or anode (+).

If instead of being made of an insoluble material the anode B consists of a sheet of copper, then as the electric current passes the copper will go into solution. Furthermore, the copper will pass into solution at the same rate as the metal is plated out upon the cathode A; theoretically, therefore, the strength of the solution will remain constant. As a matter of fact, owing to secondary changes, after a time it becomes too concentrated.

* When two pieces of metal connected with the opposite poles of an electric battery are immersed in a solution, as shown in the figure, these pieces of metal are called electrodes.

Electroplating was first suggested by Elkington in 1836, but he did not apparently employ it on an industrial scale. It is very interesting to note that some of the articles obtained from the coffins of the Egyptian mummies have been found to be coated with copper; probably, however, the coatings of copper in these cases were produced by simple immersion. On an industrial scale electroplating was first introduced by M. H. Jacobi, of St. Petersburg, in 1838. Since then, especially of late years, an enormous industry has been developed. By simple immersion heavy deposits of metal cannot be obtained, but coats of any thickness can be produced by electro-galvanising. In this article it is intended to deal not with plating in general, but with the application of the electric current for producing electrotypes or reproductions; this form of electro-deposition is sometimes called galvanoplastic.

In all cases of reproduction the article to be reproduced is made the cathode in a bath of copper sulphate, and a strip of copper the anode. Now, supposing it is desired to reproduce a medallion, if this be of metal and is made the cathode, copper will be deposited upon it, but the copper will adhere so firmly that it will be impossible to remove it. It is, therefore, necessary to

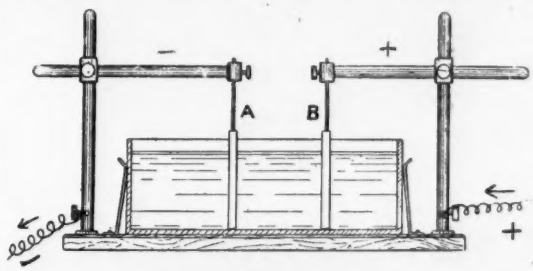


Fig. 1.

coat the medallion with an extremely thin film of some material which will prevent the deposited metal from adhering to the metallic surface. This coating must not be sufficiently thick to obliterate or blur the details of the figures, &c., upon the article which it is desired to reproduce. There are several methods which may be employed. If the medallion is of silver or copper, its surface after being carefully cleaned so as to remove dirt or grease, is washed with a solution of sodium sulphide, by which means the surface of the metal is coated with an extremely thin film of sulphide of the metal. This surface is conducting, but prevents the deposited metal from adhering to the article. Another method is to cover it with a thin coating of black lead (plumbago). The coating must be very thin and should be polished in much the same way as the iron-work of a fire-place is polished. In practice, machines are generally used for polishing and plumbagoing surfaces, as it is not an easy matter to get a perfectly smooth and even surface by hand.

Having satisfactorily prepared the surface of the article, it is hung by means of a copper wire in the depositing bath and connected with the negative pole of the source of current. The conducting wire where it dips below the surface of the copper solution should be covered with an insulating material, such, *e.g.*, as a piece of rubber tubing. As soon as the circuit is closed and the current passes, the surface of the article becomes coated with a thin film of copper, which gradually increases in thickness, until a coating of about $\frac{1}{4}$ to $\frac{1}{2}$ a millimetre in thickness has been obtained. It

XUM

should be mentioned that the back of the article is coated with some non-conducting material, such as solid paraffin wax, otherwise the whole article would become covered with copper, and it would then be impossible to remove the deposited metal. In depositing the metal certain precautions have to be taken. Thus, for example, the regulation of the current strength (current density) is a matter of great importance. If a heavy current is employed, the copper is very apt to

A

B

Fig. 2.

be deposited in a rough and irregular form, and may be so powdery as to actually rub off. The colour of the copper is bright, and the appearance smooth and regular when low currents are employed, but it is rough and brown (burnt) with currents of too great intensity.

When a sufficiently thick deposit has been obtained the article is removed from the bath, well washed with water, and dried. The point of a pen-knife or other sharp instrument is then inserted under the edge of the deposited metal and the metallic coating carefully stripped from the article upon which it has been deposited. Sometimes it is rather difficult to strip it without bending and injuring the thin metallic shell, and when this takes place it is not by any means an easy matter to properly smooth it out again. The thin shell thus obtained is backed up with lead or with an alloy of lead, which melts at a lower temperature than the lead itself. In order that the backing metal may adhere satisfactorily, the back of the shell must first be tinned; a satisfactory tinning mixture consists of an alloy of 50 parts lead and 50 parts tin. The backing metal is then run in; a useful alloy for this purpose consists of 90 parts lead, 6 parts antimony, and 4 parts of tin. Wood's alloy is sometimes used, but is too expensive for ordinary practice. It consists of an alloy of lead, tin, cadmium, and bismuth, and melts below the temperature of boiling water.

A complete copy of a medal can be obtained by depositing the metal first on one side and then on the other. The two shells thus obtained are, after tinning,

Fig. 3.

placed back to back and the fusible alloy run in between them. After filing and polishing the edges, copper can be deposited on the rim when the whole—reproduced—medal appears to be composed of copper. Fig. 2, A and B, shows a photograph of two sides of a medal commemorating the French revolution, and reproduced in the above manner. The original medal was in this case coated with sulphide. It is seen that by the above method even the faintest lines are reproduced, and we are thus able to obtain an absolutely exact replica of medallions or engravings.

Another and more commonly employed method is to make a cast or matrix of the object which it is desired to reproduce. This may be done in a variety of ways. Sometimes a metallic cast is made directly from the die, and upon this cast a thin film of copper is deposited. Fig. 3 shows such a reproduction which was cast in soft metal, then thinly coated with copper and treated so as to give it the appearance of bronze. The medal appears, in fact, exactly as if it was made of bronze.

Another method, and the most usual, is to prepare a plaster cast and render this impervious to water by impregnating it with melted paraffin, after which the surface is coated with graphite to make it able to conduct the electric current. Sometimes instead of

Fig. 4.

graphitising, it is coated with a thin film of silver by chemical means. After having been rendered conducting, the cast is made the cathode in a plating bath and metal deposited as already described. When a suffi-

Fig. 5.

ciently thick deposit has been produced the cast is taken out of the bath, the deposited metal removed and backed up as already described. The deposited metal gives a faithful reproduction of the original medal. Fig. 4 was reproduced from a plaster cast.

Instead of using plaster to make the cast, gutta-percha or mixtures of gutta-percha and other substances are often employed. Fig. 5 is rather interesting. It was made from a gutta impression. Happening to be short of gutta, my assistant, Mr. W. C. Prebble, to whom my thanks are due for preparing the medallions illustrated in this article, produced two golf balls, and the gutta from the interior of these was employed for making the matrix. The gutta was first kneaded in hot water to render it plastic, and then carefully worked on to the medal, after which it was pressed in a letter-press; hydraulic presses are often used on a commercial scale. The matrix so obtained was made conducting with finely-powdered graphite and was then placed in the depositing bath. This medal contained a great amount of detail, and I think it shows how extremely useful a golf ball may be on occasion. On a future occasion further illustrations of the uses and applications of the electric current in reproduction work may be given.

Photography.

Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Dr. Russell's Experiments.—The production of the developable condition in silver bromide, when it is exposed to the action of certain clean metals, notably zinc, and other substances such as turpentine, boiled oil, printers' ink, and sections of wood, is still obscure. Dr. Russell has found that a very minute porportion of the vapour of hydrogen peroxide is able to produce a similar effect, and that hydrogen peroxide is produced when many, if not all, of the substances found to be active are exposed to the air, as they are in the experiments. Again, Dr. Russell has shown that whatever it is that affects the plate, it behaves in some ways like a vapour or gas. It appears to be carried along a tube by a current of gas, it creeps over the edges of plates when they are placed with their glass sides towards the active substance, and so on. If this was all that there is to be said, we should probably rest satisfied with the idea that hydrogen peroxide itself is the active agent. But some of the experiments render it difficult to believe that it is only the production of a vapour at the surface of the active substances, which diffuses, as a vapour would diffuse, towards the photographic plate. Dr. Russell himself has several times drawn attention to this difficulty, though latterly he has apparently passed it over, considering that his experiments prove that hydrogen peroxide is the active agent in spite of it.

Dr. Russell has shown that gelatine is not porous; therefore it may be assumed that if a vapour passes through it, it must be absorbed on one side of the gelatine sheet, work through it, and be given off at the other side. He has shown that it does take time to pass through, but the difficulty is that a practically sharp reproduction of the active surface is obtained instead of a considerably blurred image, such as one would expect from an active vapour passing through such an obstruction. Dr. Russell has said "a good

clear picture" is obtained "even with two sheets of gelatine." When there are interposed "even as many as six or more sheets, still the picture of the scratches is distinct." "It is remarkable that such a vapour should readily pass through media such as gelatine, celluloid, etc., and not by mere absorption, but in such a way as to produce a picture of the surface from which it emanated." "The remarkably clear pictures . . which can be produced through a sheet, or even several sheets, of the thin gelatine, proves that the action is not one of mere absorption." In his third paper on the subject, read before the Royal Society, Dr. Russell says, "How then does the peroxide permeate the gelatine? Not by the ordinary process of diffusion, for hydrogen cannot diffuse through it, so that it must be by a process of dissolving, or very feebly combining with the medium, or with a constituent of it, and, thus travelling through, escape on the other side. That the action is of this nature seems rendered probable by the following experiments." These experiments consist in placing a succession of plates, each for twenty minutes, over a solution of hydrogen peroxide covered with a thin sheet of gelatine, and show that the active agent apparently takes time to penetrate the gelatine. The first plate showed no result, the second a slight action, the third still more, and so on. The same kind of action takes place if zinc is used instead of hydrogen peroxide, or celluloid instead of gelatine.

Thus the production of a detailed image, although several sheets of gelatine were interposed between the active substance and the plate, was acknowledged by Dr. Russell as difficult to understand, and he says in another place that it "seemed to prove that the action was not a mere absorption on the one side and a giving out on the other." The effect points to the obvious suggestion that the effective agent is some form of radiant energy. In 1898 I suggested that as all the active substances experimented with in this connection were susceptible of oxidation by mere exposure to air, and as during their vigorous oxidation (combustion) a form of radiant energy which will affect a photographic plate was certainly produced, it might be that the slow oxidation produced a similar form of radiant energy, just as the total heat effect is supposed to be the same whether the oxidation is slow or rapid. I pointed out the relatively enormous exposures given in Dr. Russell's experiments. One ten-thousandth of a second is certainly ample time to produce the developable condition in the silver salt of a gelatine plate when it is exposed to burning zinc, and it seems not unlikely that an exposure of, say, six hours to the slowly oxidising metal should produce a similar effect, for this increase in the time of exposure is equal to the increase of from one second to more than six-and-a-half years.

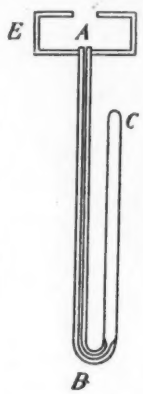
There have been other opinions expressed, and suggestions offered, with regard to the character of the cause of these effects, and these I propose to refer to next month.

Zambex cameras—flat film changing.—These cameras now being introduced by Messrs. R. and J. Beck, are distinguished by the novel and ingenious method of changing the films. This operation is accomplished by opening wide the solid hinged lid at the back of the camera, so that the zambex envelope, which is rather more than twice the length of the film, is opened out flat and to its full length. A numbered tab, corresponding to the exposed film, is then firmly drawn along away from its position in front of the bundle until it is in that part of the envelope that is attached to the lid. This leaves the next film ready for exposure, the lid, of course, being first closed. The film carriers are pieces of moderately stiff black paper with projecting tabs to pull them by, and they are attached to one another by thinner paper that rolls over as each is drawn along, and so prevents any friction against the surface of the next film. If it is desired to focus, the exposed films may be pushed back into their original position, and the envelope with its whole charge removed to make room for the screen. On replacing the arrangement for the next exposure the exposed films are drawn up again. When the last is exposed, the film carriers are all pushed back, and the envelope, with its contents in the same relative positions as before use, is removed to make room for a new one. The zambex skeleton, or series of carriers, in its envelope, may be obtained loaded with films, and then all the changing operations are done in daylight; they are also supplied empty, that the user may charge them with any films preferred. The skeletons may be used five times if desired, being provided with five holes to take a staple that retains all except the one that is being removed from the front. Zambex skeletons are also made to carry three plates instead of twelve films. The advantages of this new device are obvious. Each envelope with its full charge is less than half an inch thick, so that the packages are compact as well as light.

The Piesmic Barometer.

A new mercurial barometer, which has been designed by Mr. A. S. Davis, M.A., and has been called by him the Piesmic barometer, is an ingenious adaptation of an easily understood principle in the relation between pressure and volume in gases; and presents as practical advantages several new features of convenience, lightness, and trustworthiness. The action of the instrument depends on the fact that any volume of air taken at a low pressure, is more compressed than an equal volume of air taken at a higher pressure, when the pressure on each volume is increased by the same amount. The following is a description of the method of the instrument, which is of so convenient a size that it could, without very much inconvenience, be carried in the inner pocket of an overcoat.

ABC is a glass tube, the part *AB* being made of strong capillary tubing of one-tenth inch bore and *BC* being made of thin quill tubing. *AB* is seven inches long, and the capacity of the whole tube is 35 times the capacity of a single inch of the capillary tubing. The end *A* opens into a small cast-iron cistern *E* containing mercury. The air in this cistern, though not in actual communication with the external air, is kept at atmospheric pressure by communication with a small auxiliary chamber, the sides of which are of thin paraffined paper. When the tube is horizontal the mercury lies on one side of the cistern, leaving the open end *A* of the tube exposed to the air. When the tube is brought into a vertical position the mercury flows over and closes the mouth of the tube, then flows down the tube to a greater or less depth, the depth being dependent upon the atmospheric pressure at the time. If the barometer is standing at 30 inches the mercury will descend five inches; if at 29 inches it will descend six inches; if at 28 inches, seven inches, and so on. A scale of inches being placed behind the tube, the reading of the end of he mercury column against this scale shows the height of the barometer at the time.



NOTES

ASTRONOMICAL.

Professor Shaler's Comparison of the Features of the Earth and the Moon.

IN Volume XXXIV. of the "Smithsonian Contributions to Knowledge," Professor Shaler, of Harvard University, treats of the lunar features from the point of view of a geologist. He divides them into the broad classes of Maria, vulcanoids (in which apt term he includes all cup-like formations from the greatest ring plains to the smallest crater bed), reliefs (mountains or ridges), valleys and rills, and rays. He discusses and rejects the hypothesis that all or any of the vulcanoids were originated by meteor falls. Were such the cause the bolide would not only have been itself vaporised by the heat of collision, but the surface round, for many times its diameter, would have been melted, and the lava so formed would have been extremely fluid and more than sufficient to fill up the pit caused by the entrance of the bolide. Neither have we evidence on the earth of such numerous and great meteor falls as would be necessary to account for the great number of lunar craters. Though the lunar vents indicate some process of eruption it is evident that this cannot be identical with that on the earth. Terrestrial volcanoes are due—at least mainly—to water buried by aqueous sedimentation, and such occluded water, or its dissociated gases, we cannot admit upon the moon. Professor Shaler suggests some kind of boiling, such as will take place in any fluid mass which is heated below and cooled on the surface (as in molten iron), where substances in the vaporous state, though they exist, are not present in sufficient quantities greatly to affect the movement, or there is a circulation mainly impelled by the escape of imprisoned vapours.

* * *

But the Maria are attributed by Professor Shaler to the fall of great bolides, though many of the arguments, which caused him to reject this as the origin of the vulcanoids, hold good. Besides the Maria are arranged in such symmetrical fashion, almost exclusively in the moon's northern hemisphere, that it seems impossible to consider them as owing their origin to such haphazard casualties as a meteor fall. Professor Shaler considers that the low ridges which extend for many miles across the Maria are more nearly analogous to terrestrial mountain chains than the rugged reliefs which are usually called mountains on the moon. The light rays, he considers, owe their hue and brightness under a high sun to a crystalline deposit which reflects sunlight chiefly when vertical. This is almost proved by their shining also under earthshine, and the bright patches are probably of the same nature.

* * *

The problems raised are numerous, and Professor Shaler states several in a manner that may help to their solution. As regards the vexed question of change on the moon, he strongly decides against the possibility of present volcanic action. If Linné has changed he attributes it to the creeping action caused by the great changes of temperature, assisted perhaps by a blow from a chance meteor. As to the presence of organic life, he points out that there is none at all on terrestrial mountain peaks above 20,000 feet, where the earth's atmosphere is but one-third its density at the surface. Organic life has failed to adapt itself here to the conditions, much less could it originate. How then can we conceive of it on the moon?

* * *

For one problem he can suggest no solution. If meteoric dust falls on the moon in the same proportion as on the earth —and we have no reason to suppose otherwise—and during past time in as great quantities as now—and we have no reason to suppose that it was less—how is it that the moon, unprotected by any atmosphere, has preserved its clean reliefs and its varied hues, and has not had all masked under a uniform veil? Especially how is it that the bright rays—differing widely in the date of their origins—which seem but stains on the surface, are still bright, and the older rays no less bright than the later?

* * *

Return of Tempel's Second Periodical Comet.

Three short-period comets belonging to the Jupiter family were discovered by Herr Tempel. Of these the one discovered in 1873 has the shortest period, and was due to return to perihelion this year. It was re-detected by M. Javelle with the 30-inch refractor of the Nice Observatory on November 30, though it was of the most extreme faintness, and set within three hours after the Sun. It appears to have been seen only on two nights, but the observations show a most gratifying precision in M. Coniel's ephemeris; the error being only four seconds of time in R.A, and four seconds of arc in declination. But for M. Javelle's two observations the comet would probably not have been seen at this return at all. Its previous appearances were in the years 1873, 1878, 1894 and 1899; the returns of 1883 and 1889 having been unobserved.

* * *

Discovery of a New Comet.

A new comet, about the 11th magnitude in brightness, was discovered on December 17 by M. Giacobini, of the Nice Observatory, just on the borders of the two constellations of Hercules and Corona Borealis. It was a morning object, moving in a north-easterly direction. It will not become at all a conspicuous object, as the following elements show:—

$$T = 1905 \text{ Jan. } 3d., 2814, \text{ Berlin M.T.}$$
$$\left.\begin{aligned} \omega &= 75^\circ\ 9'\cdot8 \\ \Omega &= 225\ \ 1\cdot2 \\ \iota &= 103\ \ 27\cdot3 \end{aligned}\right\} 1904\cdot0$$
$$\log q = 0\cdot27173$$

The inclination being very great and the motion retrograde, it is exceedingly unlikely that the comet is a periodic one. Its perihelion distance is large, lying much outside the orbit of Mars.

* * *

The Great Red Spot of Jupiter.

In *Astronomische Nachrichten*, No. 3983, there are two interesting notes on Jupiter's great red spot, by the experienced observers, Mr. A. Stanley Williams and Mr. W. F. Denning. The two notes are all the more interesting in that they seem to indicate very different results. Mr. Stanley Williams gives the value for the relative period of the spot as 9h. 55m. 41·52s. in 1903 from 485 observations, as compared with 9h. 55m. 39·66s. in 1902, and writes: "This is a remarkable increase from the value obtained in the preceding year. The changes during the past five years have, in fact, been very considerable. . . Such large and comparatively sudden changes are particularly interesting in the case of an object like the red spot, since in conjunction with its unchanged aspect they appear to indicate, firstly, the relatively great rigidity or solidity (using this word in a comparative sense) of the spot itself, and secondly the mobility of the material surrounding it, and in which it appears to float. There was no noticeable change either in shape or appearance last year, though, owing to the higher altitude of the planet the spot was a comparatively easy object, and its outline could be distinguished without difficulty. There may, however, have been a slight real increase of plainness."

Mr. Denning, on the other hand, finds for the rotation period during the last seven months, 9h. 55m. 38·6s., which, he writes, "is shorter than any period it has exhibited since 1883. In 1883 it was 9h. 55m. 38·2s., and in 1884 9h. 55m. 39·0s. The spot is now very faint. Its variable motion in recent years has been very curious, and it will be highly interesting to watch this object during ensuing months, and trace out any further changes in velocity."

XUM

Refraction in Planetary Occultations.

A lunar occultation is usually an instantaneous phenomenon, the moon possessing no atmosphere sufficient to cause a sensible refraction of the light of the star occulted. But several of the planets evidently possess considerable atmospheres, and it might at first sight be expected that an occultation of a star by one of them should show a noticeable effect; a retardation of the disappearance and an acceleration of the reappearance. Dr. T. J. J. See in No. 3984 of the *Astronomiche Nachrichten* shows that in general there is a zone of irradiation round the disc of a planet many times the greatest admissible depth of the atmosphere. A daylight occultation would be free from this irradiation effect, but the observation of such an event under good conditions must be most rare; whilst in an occultation at the dark limb in the case of Mars or Venus the limb of the planet would be unseen, and "it is difficult to see how any result of value could be obtained."

* * *

The Greenwich-Paris Longitude.

M. Loewy, in a communication to the Paris Académie des Sciences gives the final result of the determination of the difference of longitude between the two Observatories which was carried out by MM. Bigourdan and Lancelin in 1902. Some small differences were noted between the values obtained in September, 1902, and those in April and May, which are ascribed to slight changes in personal equation. The mean result gives the difference of longitude as 9m. 20·974s., the value found independently by the two English observers, Messrs. Dyson and Hollis, being 9m. 20·94s.; a difference of only the thirtieth of a second of time. The difference of longitude between the two meridians may therefore be considered as now known with most gratifying precision.

* * *

Sunspot Spectra.

The Rev. A. L. Cortie, S.J., gives in the *Astrophysical Journal* for November an interesting summary of his observations of sunspot spectra during the years 1883-1901. His spectroscope was an automatic twelve-prism instrument by Browning, each prism being of 60° refracting angle. The region examined was the red and yellow; from B to D; and 349 lines are contained in the catalogue of widened lines—the individual observations being 5486 in number.

The summary of results shows the important part played by the faint lines of vanadium and titanium in the spectra of sunspots. Lines which in the earlier observations were classed as of unknown origin have since been found to be due to vanadium or titanium. These faint lines are always at all times of the sunspot period among the most widened lines; λ 6243·06 of vanadium being particularly noticeable. Father Cortie finds no evidence of the "crossing points" when these vanadium and titanium lines give way to lines of iron, such as Sir Norman Lockyer has insisted upon so strongly; nor is he inclined to admit that there is warrant for concluding that there is an essential difference of character or temperature between maximum and minimum spots. He regards the widening of some of the oxygen lines, especially in the *a* band, as a real phenomenon, but considers that the apparent evidence for the widening of lines accredited to water vapour requires support from further research before it can be definitely received.

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The Astronomical and Scientific Bequests of Mr. Frank McClean.

Mr. Frank McClean, F.R.S., has made the following bequests: £5000 to the University of Cambridge, to be expended in improving the instrumental equipment of the Newall Observatory; £5000 to the University of Birmingham for physical science; £2000 to the Royal Society; £2000 to the Royal Astronomical Observatory; £2000 to the Royal Institution; and to the University of Cambridge, for presentation to the Fitzwilliam Museum, all the testator's illuminated or other manuscripts and early printed books, and all objects of mediæval or early art which the Director of the Museum may select as being of permanent interest to the Museum.

The Medals Awarded by the Royal Society.

The Copley Medal has been awarded to Sir William Crookes for his experimental researches in chemistry; the Rumford Medal to Professor Ernest Rutherford for his researches on the properties of radio-active matter; one Royal Medal to Professor W. Burnside, on the ground of the number, originality, and importance of his contributions to mathematical science; the other Royal Medal to Colonel David Bruce for his successful researches into the causation of a number of important diseases affecting man and animals; the Davy Medal to Professor W. H. Perkin, jun., for his researches in the domain of synthetic organic chemistry; the Darwin Medal to Mr. William Bateson for his researches on heredity and variation; the Sylvester Medal to Professor Georg Cantor for his researches in pure mathematics; and the Hughes Medal to Sir Joseph Swan for his invention of the incandescent electric lamp and his other inventions and improvements in the practical applications of electricity.

BOTANICAL.

By S. A. SKAN.

IT is announced in the December number of the *Botanical Magazine* that Sir J. D. Hooker, who has been the editor of this famous periodical for the long term of forty years, retires from that position with the completion of the volume for 1904, on account of his great age, Sir Joseph now being in his eighty-eighth year. It is further stated that a new series begins in January, 1905, with Sir William Thiselton-Dyer, K.C.M.G., Director of the Royal Botanic Gardens, Kew, as editor. For some time past Mr. W. Botting Hemsley, F.R.S., has given Sir J. D. Hooker a great deal of assistance in carrying on the work, most of the text in the last volume having been contributed by him. The *Botanical Magazine* has now appeared uninterruptedly for 118 years. Mr. Hemsley, in his interesting history of the work, which was published in the *Gardeners' Chronicle* in 1887, refers to it as "having long outlived the numerous rivals and imitators which its successful career gave rise to from time to time. Indeed, it is doubtful if it is not the only illustrated serial ever published that has enjoyed a century of unbroken vitality."

* * *

In the *Comptes Rendus*, Vol. CXXXVIII., p. 293, Messrs. Bouilhac and Giustiniani have an interesting article on the important question of the utilisation of free nitrogen by various higher plants through the medium of certain freshwater algæ (*Nostoc punctiforme* and *Anabæna*) associated with bacteria. Nitrogen, one of the essential constituents of plant food—the development of proteid substances depending on its presence—though so abundant in the atmosphere, is shown by experimenters, amongst whom may be mentioned De Saussure, Boussingault, Lawes and Gilbert, to be inaccessible to plants in its uncombined state, and that the majority of them are dependent for their supply of the gas to nitrogenous manures incorporated with the soil in reach of their roots. Leguminosæ are remarkable in being able to make use of the atmospheric nitrogen, which is fixed and rendered diffusible for them by the agency of bacteria infesting the nodules often found in abundance on their roots. The writers referred to at the beginning of this note show that other plants besides Leguminosæ, such as buckwheat, mustard, cress and maize, will thrive when the source of nitrogenous food is restricted to the nitrogen of the air, so long as certain algæ and bacteria are present in the soil. These appear to be able to convert the gas into a form accessible to the plant in the same way as do the bacteria in the root-nodules of the Leguminosæ. Messrs. Dehérain and Demoussy had previously ascertained that even a leguminous plant (*Lupinus*) would flourish in soil deprived of nitrogenous ingredients, and without developing nodules on its roots, if algæ were present.

ORNITHOLOGICAL.

By W. P. PYCRAFT.

Breeding Habits of Pterocles Exustus.

MR. W. H. ST. QUINTIN, in the December number of the *Avicultural Magazine*, gives an exceedingly interesting account of the habits of the greater Pintailed Sandgrouse (*Pterocles exustus*), which he has succeeded in breeding in his aviary this year—the first record of the kind in this country.

In the course of his essay he describes the curious method which the birds have of watering their young. As this is probably new to most of our readers we venture to reproduce it here. "The young," he says, "no doubt are somehow able to make it clear to their male parent that they wish to drink, and he starts off to the pan, and, after sipping a little on his own account, steps in and stands motionless for a minute or two watching. Then he sits down in the water, and goes through a shuffling movement very like a bird that is dusting. After remaining in the water several minutes he gets out and hurries off loudly calling to the young, who, if old enough, run to meet him. Then follows what reminds me more than anything of a mammal suckling her young; the chicks push their heads amongst the breast-plumage and under tail-coverts, evidently taking the water off the feathers by passing them through their bills, moving to fresh places as the supply becomes exhausted."

Pterocles alchatus has the same custom; a fact first noticed by Mr. Meade-Waldo. As in the species just described, only the male undertakes this work.

The habits of these birds in confinement thus throws unexpected light on certain peculiar habits seen in wild birds of these species and the allied *Pterocles arenarius*, which were observed by Mr. Meade-Waldo soaking their breasts in puddles about the village wells in Morocco and then flying off.

* * *

Breeding Colonies of the Flamingo.

In a charming and beautifully illustrated article in the *Century* for December, Mr. Frank Chapman describes the breeding habits of the Rosy Flamingo (*Phœnicopterus ruber*). His observations were made in the Bahamas; and since but little is known of the breeding habits of Flamingos, his account will be eagerly read by ornithologists.

If any doubt still lingers in the mind of any of our readers as to the truth of the old story of the method of incubation which these birds, on account of the great length of their legs, were obliged to adopt—brooding the eggs by sitting astride the nest!—they should be dispelled by Mr. Chapman's photographs.

In view of the opinions which have been expressed as to the systematic position of the Flamingo, it is interesting to notice that the young are goose-like rather than stork-like, inasmuch as they are precocious. Nevertheless, unless suddenly alarmed, they remain in the nest for a few days after hatching, and are fed by the parents on what is described by the author as "regurgitated clam broth," which is taken, drip by drip, from the parent's bill. It would seem, however, from the author's description that only their first meal is of this character, and that henceforth the birds feed themselves under the parents' guidance. Thus, in this matter, they further resemble the Anseres.

Unfortunately, owing to the unavoidable publicity which Mr. Chapman's search for these birds occasioned, this huge colony is doomed to extinction. Hitherto undiscovered, its whereabouts has now become known to the negroes of the island. And as fresh meat is "rarer then pink pearls" in the outer Bahamas, and young Flamingos are regarded as excellent eating, a relentless war on the colony has begun.

* * *

Sabine's Snipe in Cambridgeshire.

A remarkably fine specimen of the so-called Sabine's snipe was killed in November at Fulborn, Cambridge, on the estate of Captain Tryon.

Now known to be only a melanistic variety of the common snipe, this bird yet presents some striking points of difference from the normal type. Though I have recently examined several specimens, in none have I remarked the characteristic longitudinal striping on the upper parts, or the bars on the axillaries.

The present bird, a female, may be described as velvety black above, relieved by brown markings, forming horse-shoe shaped bars at the tips of the feathers of the scapulars and mantle. The dark colour around the face was so intense as to form a sort of mask, comparable in area to that of the black-headed gull in summer dress. The beak and feet were of the normal colour.

Only in a few rare instances has the sex of these varieties been recorded, though between fifty and sixty examples are known. Of these, thirty-one have been obtained in Ireland, twenty-two in England—the present specimen makes the twenty-third—one in Scotland, and one in France.

This appears to be the first record for Cambridgeshire.

* * *

The Thrush-Nightingale in England.

The first authentic British-killed example of the thrush-nightingale (*Daulias philomela*) was obtained at Smeeth, Kent, on October 22, and was exhibited at the British Ornithologists' Club on November 16. It proved to be a male.

Known in Germany as the "Sprosser" nightingale, this species differs from the common nightingale in its somewhat larger size and the presence of faint spots on the throat; but it is inferior as a songster, as compared with its smaller relative.

* * *

Water Pipits at Rye Harbour.

An immature male water-pipit (*Anthus spipoletta*) was shot at Rye Harbour, Sussex, on October 26, 1904. It was procured out of a flock of rock-pipits. On November 19, a female, also an immature specimen, was killed at Pevensey Sluice, Sussex.

Mr. M. J. Nicoll, who exhibited these birds at the November meeting of the Ornithologists' Club, remarked that he had but little doubt that the water-pipit was a regular visitor to England during the autumn migration, but escaped notice owing to its resemblance to the rock-pipit.

They seem to prefer salt and brackish pools as a feeding ground.

* * *

Spotted Crake in Co. Antrim.

A young female Spotted Crake (*Porzana maruetta*) was killed on October 8 at Templepatrick, Co. Antrim. This makes the sixth occurrence of this species in Co. Antrim.

* * *

Immigration of Lapland Buntings.

A small flock, at least, of Lapland Buntings (*Plectrophanes lapponica*) would seem to have reached our shores this autumn, inasmuch as a bird of this species was taken in a trap at Acock Green, near Birmingham, on November 21; and two on the denes at Great Yarmouth, a female on the 18th and a young male on the 24th of November.

* * *

Hoopoe in Cheshire.

An immature Hoopoe was, records the *Zoologist*, shot in a potato field at Sale, Cheshire, on September 21. This bird had been seen in the neighbourhood since the 17th, and was very tame—a trait which unfortunately cost the wretched bird its life! These birds would undoubtedly breed in this country if left alone when they arrive in the spring, as many do.

* * *

Black-necked Grebe breeding in Great Britain.

Mr. O. Aplin has a most interesting account of the breeding of five pairs of the Black-necked Grebe (*Podicipes nigricollis*) on a lake, the geographical position of which he most wisely refuses to disclose. His notes contain some valuable observations on the habits of the old birds and their care of the nestlings.

XUM

Although these birds have been suspected of breeding more than once on the Norfolk Broads, and perhaps in Ireland, no satisfactory proof thereof has ever been brought forward.

* * *

Oyster-Catcher Swimming.

In the *Irish Naturalist* for December Mr. C. J. Patten gives a long account of an Oyster-Catcher which, on finding itself observed when feeding along the water's edge, raced along the beach and, taking to the water, swam out to sea for a distance of 200 yards. Later, on its return to land, he succeeded in heading it off and running it down, when he found that one wing had been injured, apparently some days previously. The bird is now in the Dublin Zoo.

ZOOLOGICAL.

By R. LYDEKKER.

Black Foxes.

ACCORDING to the Norfolk *Weekly Standard* of October 22, a litter of black foxes was bred last spring in the Bedale country, on the estate formerly belonging to the late Duke of Cleveland. If authentic, this event would appear to be unprecedented, but, as has been recently pointed out by a writer in the *Field*, young foxes are normally slate-coloured, and the statement may be based on this fact. Be this as it may, Mr. J. E. Millais, in the first volume of his magnificent new work on "British Mammals," after mentioning that a tendency to melanism is by no means uncommon in the species, records only two instances of completely black foxes. The first of these occurred in the New Forest, and is referred to in the *Zoologist* for 1890, the second was reported from Leicestershire in 1903. The old legend that to hunt a black fox implied certain death to the pursuer indicates, however, the occurrence of such instances in former years. In this connection it may be noted that a writer in the November number of the *Zoologist* states that both melanistic and albino animals are generally inferior in size to their normally coloured fellows.

* * *

The Fallow Deer as a British Fossil.

In the course of a paper on the contents of a Derbyshire cavern read before the Geological Society on November 23, the authors, Messrs. A. Bembrose and E. T. Newton, referred to a large number of remains which they identified as belonging to the fallow deer. These were stated to have been found with those of undoubted Pleistocene mammals at all horizons in the cavern strata. Now, fallow deer remains have hitherto been unknown from any Pleistocene British cave; and since fallow deer are just the kind of animals whose carcases would be carried into caves by hyænas, it was argued in the discussion which followed the reading of the paper that if their remains are absent from all other cavern-fauna, they are not likely to occur in this one. The argument is no doubt a strong one, but if the remains are rightly identified (and this was not disputed) it seems difficult to account for their occurrence among the Pleistocene remains, otherwise than according to the views of the authors of the paper. It may be added that numerous fallow deer remains have been described from the peat of Denmark.

* * *

The Whales of the N.W. Atlantic.

Important whale-fisheries have been established of late years on the coast of Newfoundland, and the enormous amount of material thus made available to the naturalist has been taken advantage of by Mr. F. W. True, an American zoologist who has devoted special attention to the study of this group of the cetacea. The results of his investigations have recently been published at Washington by the Smithsonian Institution in a quarto volume, illustrated by no less than 50 plates showing the carcases of whales as they are landed at the Newfoundland factories. Five or six different kinds of whales are taken at the establishment, of which the great majority (both as regards species and individuals) are rorquals, or finners, of the genus *Balænoptera*, that is to say, whales with short whalebone, and of a long and slender shape, adapted for swimming at a great pace. A certain number of humpbacks (*Megaptera*) are, however, captured, while occasionally a sperm-whale (*Physeter macrocephalus*), and, still more rarely, a Biscay right-whale is taken. All the species met with on the American coast seem identical with those found on our own side of the Atlantic. The most abundant is the common rorqual, whose scientific title (*Balænoptera musculus*) the author seeks to transfer to the "sulphur-botlarn," generally known as *B. sibbaldi*. Apart from the rights of the case, such a shifting of well-established names can have no possible advantage, and must inevitably lead to confusion.

* * *

Deaths from Snake-Bite and Wild Beasts.

The mortality in India due to the attacks of wild beasts and snake-bite, according to the Government returns for 1903, maintains its usual appalling magnitude, showing, indeed, an actual increase in some items, although there is a decrease under other headings. The total mortality among human beings reported to have been caused by wild beasts during the year was 2749, against 2536 in 1902; the increase being largest in Madras (236) and the United Provinces (90). The destruction of life by tigers was, however, considerably less than during the previous year, the number being 866, against 1046; the greatest decrease in this item being in Bombay, while Madras showed an increase. On the other hand, the deaths from wolves rose from 338 in 1902 to 463 in 1903; the great bulk of these being attributed to a few which have taken to man-eating. The deaths from snake-bite fell from 23,167 in 1902 to 21,827 in 1903; Bengal alone accounting for 10,394. Of the remainder, 4964 deaths are credited to the United Provinces, 2011 to Madras, 1008 to Bombay, 1031 to Burma, and 1386 to the Central Provinces.

* * *

The Old Rhinoceros at the "Zoo."

At the time of writing these Notes, the Indian rhinoceros presented to the Zoological Society by the late Mr. A. Grote, on July 25, 1864, was reported to be in a moribund condition. This animal affords a wonderful instance of longevity in captivity. It has since died.

* * *

The First Fruits of the "Discovery's" Voyage.

The first description of a new animal "discovered during the voyage of the *Discovery*" is apparently one in the December number of the *Annals and Magazine of Natural History*. In this Mr. T. V. Hodgson gives a preliminary notice of a peculiar type of "pycnogonid," or "sea-spider," distinguished from all its relatives by the presence of an additional pair of legs, which brings up the number to five. On this account, although it is admittedly very close in other respects to the well-known *Nymphon*, the new form is made the type of a genus by itself, under the title of *Pentanymphon antarcticus*.

* * *

Papers Read.

At the meeting of the Geological Society on November 23, Messrs. Bembrose and Newton communicated a paper on the contents of a Derbyshire cavern, to which fuller reference is made in an earlier paragraph; the Ammonites of the group *Lytoceratidæ* formed the subject of a communication by Mr. S. S. Buckman at the meeting of December 7. At the meeting of the Linnean Society on November 13, Mr. G. B. Buckton described certain hemipterous insects of the family *Membracidæ*. Captain Crawshay, at the meeting of the Zoological Society on November 29, communicated some notes on the habits of the lion; and the sixth part of Sir C. Eliot's contributions to our knowledge of the nudibranch molluscs of East Africa was also taken. Mr. Lydekker, in addition to describing certain forms of loris, or oriental lemurs, exhibited photographs of paintings of animals in the possession of H. M. the King at Windsor Castle. The other papers included one by Dr. Hagen on certain crustaceans, one by Mr. Boulenger and another by Mr. Beddard on lizards, and a fourth by Mr. Gurney on South African entomostracous crustaceans.

XUM

Heredity.

By J. C. SHENSTONE, F.L.S.

I.

IT is now three centuries since "Gilbert" of Colchester taught us to practise the method of reasoning from observation and experiment. Since his day, hosts of workers have attacked natural phenomena by inductive methods, and with such success that the present state of knowledge in chemistry and in physics affords us reasonable ground for hoping that before long equal progress may be made in the study of plants and animals. It may, therefore, interest the readers to consider what advance has been made in the latter branches of knowledge.

I have selected "Heredity" as the subject of this article because it is peculiarly identified with living things, and because it is a subject of such importance to the human race that it appeals to us more forcibly than any other branch of enquiry.

The origin of our domesticated animals and of wheat and barley are lost in antiquity; these must have been obtained at some very remote period, by a gradual process of cultivation and artificial selection from wild animals and wild plants, the varieties best suited to man's requirements having been selected for the production of the food supplies required by early men. We also find the ancestry of men carefully traced in the Biblical and other very early records; we may therefore conclude that heredity attracted attention as far back as history carries us. But the knowledge of our ancestors was confused with much error, and no solid advance towards discovering the principles of heredity was possible until the great Swedish naturalist, Linnæus, had classified and arranged all known forms of plants. Linnæus was the first to realise the discord and confusion which existed in our knowledge of plants and animals until his time. And he clearly perceived that there must be a natural system which, however, could not be determined until the rules underlying Nature's own system had first been discovered. In order to enable students to search for these rules, he described and classified provisionally all known forms of plants. His system was, it is true, an artificial system; it was not founded upon actual relationship existing amongst the members included in his various groups, nevertheless it enabled naturalists to clearly indicate any particular plant to which their investigations referred, and thus removed the great difficulty which had previously existed of communicating botanical knowledge, and opened the way to solid advance towards a complete knowledge of plants and animals.

After Linnæus, progress was slow, clogged by the dogma known as the "constancy of species": the belief that every form of animal and plant owes its existence to a special act of creation. For at least a century this dogma remained as an article of faith which no naturalist could doubt without losing his scientific reputation, and the belief was strengthened by the fact that it accorded with the tenets of the Churches. This is all the more astonishing when we remember that breeders of animals had long been skilled in moulding their forms to suit the requirements of man, and that the variation of vegetables by cultivation had been practised from a period preceding the advent of Linnæus, the varieties of vegetables, of fruits, etc., being in fact increased almost daily before everyone's eyes, by processes of cultivation. The skill of the early pigeon-fanciers affords a good illustration; and one has but to tell the history of the cultivation of the rose, to show how inconsistent this dogma was with the facts which stare everyone in the face; for we find that whilst Parkinson, one of the earliest writers (1629) upon gardens, only speaks of the red, the white and the damask roses, and Gerard, at the end of the sixteenth century, describes eighteen varieties, John Ray in the seventeenth mentions thirty-seven, whilst a century later no less than seventy-nine varieties were in our gardens; quite early in the nineteenth century the number of varieties of the rose had risen to above two thousand, and to-day they are so numerous that it would be impossible to draw up a complete list. The mania which existed, during the seventeenth century and later, for producing new varieties of tulips by cultivation, affords an equally forcible illustration. Many of these varieties of plants were undoubtedly produced by hybridization; but as any attempt to change the forms of animals and plants was held to be a breach of the Almighty's law, these new varieties were frequently introduced to the public as new plants imported from foreign countries, thus hiding the real facts from the eyes of the public. These historical facts show us how strongly the dogma of the "constancy of species" had become rooted, and perhaps the greatest debt we owe to Chas. Darwin is the destruction of this dogma which had blocked all progress.

I must now introduce to the reader, Christian Konrade Sprengel (1750), for a time rector of Spandau, who, noticing that the honey in the wood cranesbill was hidden by inconspicuous hairs at the lower part of the petals, suggested that the hairs might serve to protect the honey from rain whilst leaving it accessible to insects, an observation which led him to conclude that honey is secreted by flowers for the sake of insects, and ended in his becoming so absorbed in studying the relationship of flowers and insects that he neglected his duties as rector, was removed from his post, and lived thereafter neglected and shunned by men of science as a strange, eccentric person. The book which he published upon plants and insects* met with so little support that he never brought out a second volume. Many years later Chas. Darwin was inspired by this work to investigate the subject, and his investigations resulted not only in considerable additions to Sprengel's work, but led to the complete knowledge of the sexuality of plants, a subject little understood until towards the middle of the last century.

The organs of a flower consist first of a seed vessel containing the undeveloped seed. At the apex of this seed vessel is a viscid surface called the stigma, sometimes, but not always, provided with a stalk. Secondly, of certain little bags of golden dust, the anthers, with which we are all familiar. The yellow granules of which this dust is composed, if they reach the viscid apex of the seed vessel, send minute tubes down to a cell called the "germ-cell" in the young seed and thus fertilise it. Unless the young seed is fertilised, it never matures but presently fades away and dies.

(To be continued.)

*Das entdeckte Geheimniss der Natur in Bauc und in der Befruchtung Blumen, 1793.

XUM

REVIEWS OF BOOKS.

The Moon.—"A Summary of the Recent Advances in our Knowledge of our Satellite, with a complete photographic atlas," by William H. Pickering, of Harvard College Observatory. (John Murray. Price £2 2s.)

It is the declared intention of the author of this sumptuous volume to give an account of some of the more recent advances in our knowledge of the moon, and to leave to the text-books a statement of that earlier acquired information with which most people are already familiar. This statement of Professor Pickering's intention is not quite fair to his accomplishment; because it might lead the reader to suppose that the book contained only such material as had been already presented in the author's contributions to the Harvard Observatory Annals, whereas the book might best be defined as a brilliantly interesting essay on the moon, coloured or supplemented by Professor Pickering's views of the inferences to be drawn from the latest information concerning it. Thus the first three chapters, written in a vein which will appeal to any intelligent and educated person, comprise the commonly accepted views as to the origin of the moon, the data in regard to its distance, rotation, libration, &c.; and the opinions formed within the last few years by many astronomers on the probable density and temperature of a lunar atmosphere. Some of the new views are hypotheses; some are of a nature more solid than that and are based on the Harvard "discoveries" which the splendid Arequipa station have enabled astronomers to add to the common capital of astronomic science. In another particular new "views" of the moon are presented, for the volume contains a complete photographic atlas of the moon, the plates of which cover the whole visible surface of the moon five times. Eulogy of these beautiful plates is superfluous; they have been made, and they have been selected and printed, with one object alone in view, which is that the Harvard College Observatory, and the expedition which it sent out to Jamaica in 1899 for the special purpose, should have the honour of presenting the most complete and the most scientifically useful set of photographs of the moon in existence. With, or (as Professor Pickering's opponents might say) without, some of the deductions which are drawn from his examination of the moon's surface, they mark a fine achievement, and are an enviable possession. There are nearly a hundred plates in all; and they constitute the only complete lunar atlas in existence. The first point on which Professor Pickering may be said to invite controversy is in respect of the moon's atmosphere, water and temperature. He gives observational grounds for believing that an atmosphere exists at the moon's surface, comparable in density to that which would be found at a height of about 30 to 40 miles above the surface of the earth. A haze, he adds, appears to rise to a height of about three or four miles on the sunlit side of the moon. Accepting Professor Pickering's observations as accurate, what is to be said of his explanation that water and carbonic acid gas are escaping from the moon at such a rate as to constitute an atmosphere of the kind he predicates, or to give rise to permanent snow fields? The opposed view is that the gases in question would escape too quickly from the moon's surface—the force of gravity there being insufficient to retain them—and that some other explanation must be found. Professor Pickering's hypothesis, while explaining with apparent satisfaction that the observed enlargement of the white spots of Linné towards lunar sunset and during a lunar eclipse are due to a sublimation of hoar frost, is peculiarly difficult of application to the systems of bright streaks which radiate from some of the lunar craters, and which are attributed to snow produced by allied causes. Similarly Professor Pickering, from the consideration of the darkening of certain areas of the moon's surface and their increase of size during the lunar morning, together with their disappearance towards the time of sunset, arrives at the conclusion that a luxuriant vegetation springs up on the moon, nourished by water which it derives by capillary force from the soil and fostered by the sun's heat to a giant growth that is aided by the small gravitational attraction of the moon itself. Against this hypothesis, fascinating but fanciful, we have to set the fact that no terrestrial life exists on terrestrial mountains 20,000 feet or more above the sea under atmospheric and thermometric conditions which must be vastly more favourable than those to be found on the moon. Furthermore, as another writer has said, whatever may have been the circumstances which led to the beginning of life on this earth, they were evidently of rare occurrence. The fate of the moon as a habitation for any form of life, as we know it, was probably in large part determined by the ratio between its gravitative force and the energy of the kinetic movement of the gases which constituted its atmosphere. If that energy had been sufficient to keep them on the satellite, there is no reason why it should not have had the history of a miniature earth. These postulates are palpably non-admissible, and it is most reasonable to suppose that the moon has not even vegetable life as we know it. These are, however, only "spots on the moon," and we should not be justified in regarding them as such, were they presented with any less appearance of incontrovertible and established truth, in a volume which is not a controversial work at all, but is clearly intended to inform the growing class of people who, without being experts, are deeply interested in science. If, however, they bear in mind that—to adopt an American expression—all Professor Pickering says does not "go," then in buying and reading this fine work they will be richer by the knowledge of ingenious, interesting, and fascinating theories, as well as by a solid possession of great instructional value.

Game, Shore, and Water Birds of India, with additional references to their allied species in other parts of the world, by Colonel A. E. Le Messurier, C.I.E., F.Z.S., F.G.S., fourth edition (London: Thacker and Co., 1904). Works on the birds of India are not numerous, and sportsmen, as a rule, have found them either too bulky or too technical. That is to say, these works have been designed rather for the ornithological student than the campaigner. Though the standard, in short, of these tomes has been an unusually high one, they are not adapted to the use of men who must travel with as little luggage as may be. Colonel Le Messurier was one of the first to realise this, and so far back as 1874 he prepared a volume, for private circulation only, on the "Game Birds of the Eastern Narra." Four years later—in 1878—this book was issued to the public with some slight additions. This year was made memorable in the annals of Indian Ornithology by the appearance of the first volume of Hume and Marshall's "Game Birds of India," a work which quickly made its influence felt. Colonel Le Messurier was among the first to realise the sterling value of these volumes, and we find, indeed, that in his next edition he begs to acknowledge that the additions therein made are largely taken from this source. That the author's efforts to produce a handy and portable guide for the use of sportsmen were fully appreciated may be gathered from the fact that a fourth edition has been called for. It is highly probable that this last will meet with as cordial a welcome as the earlier volumes; inasmuch as all the features which secured success for the earlier editions are preserved here, and considerable additions have been made. Viewed, however, from an entirely impartial standpoint, it must be admitted that a great opportunity has been missed in this new volume. There can be no doubt but that the introduction requires drastic alterations. As it stands it is useless alike to the scientific student and to the sportsman, and errors are painfully common. The classification adopted is antiquated. The quotation from Professor Kitchen Parker—unacknowledged, though placed within inverted commas—was more or less true when he wrote it in 1875. But in 30 years much has been done in this matter. On the question of migration, the author relies almost entirely on Professor Newton's masterly article in the ninth edition of the "Encyclopædia Britannica." But, as touching the mysterious irruptions of Pallas's sand-grouse into Great Britain, we would gather that the last of these occurrences took place in 1872! Other equally important matters are treated in the same perfunctory manner. Under a double heading, of ponderous capitals, the question of "External Variation in the Two Sexes and at Different Seasons" is discussed, and dismissed, in three paragraphs of two lines each! The subject of nidification is dealt with in 16 lines! Under the curious plea that, "owing to the facilities of travel, Anglo-Indians are now engaged in most countries either in business or pleasure," the author, in this edition, includes references to "all species in other parts of the world that are allied to the game, shore, and water birds of India." Surely even Anglo-Indians cannot contrive

to be in more than one country at one time, and since we presume their journeys are more or less premeditated, we cannot see why the author should not leave them to select the appropriate books for themselves. His own volume will certainly prove but a broken reed to trust to. It is a pity that matters utterly outside the scope of this book should have been introduced. So far as the sportsman's side is concerned, Colonel Le Messurier's guidance will be confidently followed, for he unquestionably knows his subject. But there can be no doubt that those parts which are admittedly compiled from abstruse scientific treatises, or from the labels in the Natural History Museum at South Kensington, should be ruthlessly suppressed. When they are not inaccurate, and out of date, they are out of place, and worse than useless, because they take up valuable space. An introduction giving a summary of the varied geographical features of India and the peculiarities of the avifauna of the several regions which may be distinguished would have been of immense help. To this might have been added the observations which Colonel Le Messurier must have made in the habits of birds and their relation to the environment. To those about to enter upon civil or military life in India such a chapter would be helpful indeed. A collection of native legends and superstitions concerning the birds of India would have still further added to the value and usefulness of this book. We hope that these things may yet be done. This work is profusely illustrated, but on the whole the figures are about as bad as any it has ever been our lot to criticise. These remarks are made in no spirit of captious criticism, but with a view to make of this work a really valuable, up-to-date guide to the "Game" Birds of India.

"The Cambridge Natural History" (Fishes, Ascidians, &c.), by Various Authors (Macmillan and Co., Limited; price, 17s. net). We have the greatest satisfaction in welcoming the somewhat belated appearance of this long-expected volume, as a trustworthy and up-to-date work on fishes written on more or less popular lines was a desideratum. On the whole, this volume, which is bulkier than any of its fellows, may be said to fulfil what was expected of it; although portions of it, owing to having been set up in type for a considerable time, are a little out of date; and there is a certain amount of disadvantage attending the dual authorship of the portion devoted to fishes, as it is difficult to ascertain to what extent each of the two eminent contributors is responsible for, and approves of, the general systematic arrangement of the members of the class Pisces. Before going further, it should however, be mentioned that the relegation of the sections dealing with the lower chordates to authors other than those responsible for the fishes was quite a proper, and indeed essential, proceeding; and we may congratulate Professors Harmer and Herdman on the very excellent and exhaustive manner in which they have severally treated their sections of the subject. As regards the fishes, while Professor Bridge, of Birmingham, has undertaken the morphological part of the subject together with much of the systematic work, the taxonomy of the modern bony fishes and their immediate extinct relatives has fallen to the share of Mr. Boulenger, the fish-expert of the British Museum. His rearrangement of these fishes (which has already been published in the *Annals and Magazine of Natural History*) considerably modifies previous conceptions as to the mutual relationships of some of the groups, and may be regarded as a distinct advance in systematic natural history. As a small instance of the want of uniformity due to divided authorship, we may refer to the two family names *Ostcolepidæ* and *Leptolepididæ*. As regards Mr. Bridge's contribution, it cannot fail to be noticed that the morphological side receives much fuller treatment than is accorded to the systematic section—a by no means unmixed advantage, we venture to think, in what is supposed to be, in great measure, a popular work. The chief feature in the taxonomy whereby this part of the work differs from many treatises now in use is the inclusion of the chimæras and their allies (*Chimæroidei*) in the same group with the sharks and rays (*Elasmobranchii*). The essential difference in the structure of the skull of the two groups is, in Mr. Bridge's opinion, an adaptive feature, due perhaps to the great development of the structures which serve the function of teeth in fishes of this group. We are inclined to think that the author may be right in his view; and we should be still more disposed to endorse his scheme if the chimæroids were not such an ancient group. In the suppression of the term *Actinopterygii* for the whole of the fan-finned teleostomous fishes, as opposed to the group *Crossopterygii* for the bichir and its relatives, we cannot think the author (or authors?) has been well advised. Moreover, we regret to see the familiar name *Cestracion* of the Port Jackson shark displaced by *Heterodontes*, especially as we ourselves consider the use of the latter term barred by the existence of the name *Heterodon*. As a whole, however, we cannot but express our opinion of the high scientific value of the latest volume of the excellent *Cambridge Natural History*.

"A Later Pepys," by Alice C. C. Gaussen (John Lane, 2 vols.). There was another Pepys, who followed him, and who, in the opinion of his time, as well as of his polite friends, was a much more distinguished person than the immortal Diarist. He was Sir William Pepys, Master in Chancery, born in 1740, and by reason of his great literary abilities, and his personal charm, the associate and correspondent of many who formed what we should call the literary circle of the latter part of the eighteenth century. His letters to Hannah More, Mrs. Montagu, Mr. James McDonald, Major Rennell, Sir Nathaniel Wraxall, have been preserved, and, collected in these volumes, form a very interesting and valuable record of the thoughts, manners, and conversation of these times. We should, perhaps, say now that Sir William was flattered by knowing "the best people"; but if he was proud of their intimacy and converse, they were no less proud of his, for he seems to have been emphatically one of those Men of the Time who, like others in our own day and generation, create an impression that much higher achievement was in their powers than they ever put forth their energies to grasp. However that may be, Sir William Pepys was a distinguished, amiable gentleman, to whose accomplishments his biographer's handsome volumes do ample justice. The only fault we have to find is that the letters, instead of being arranged chronologically, are grouped under the persons to whom they were addressed.

Who's Who.—One might say of the yearly publication of "Who's Who" (A. & C. Black), as already has been said of London's service of messenger boys, that we cannot imagine how the world ever managed without it. It is as indispensable to the journalist or the man of business as a rhyming dictionary is to a poet, or a "Thesaurus" to a neophyte in letters, and we feel something of the same gratitude for its unfailing readiness to supply information as we experience towards such benefactors of the public as the postman or the City policeman. It is, to speak seriously, an extremely useful and an extremely well-edited work; it contains 17,000 biographies on its 2,000 pages, and it is, take it for all in all, the cheapest seven-and-sixpenny-worth that is published. It is the Biographical Directory of the working professional man.

Whitaker's.—There is no new thing to be said of "Whitaker's Almanack," which, with the neat, concise, and handy "Whitaker's Peerage," makes its unfailing appearance at this time of year, for even if one were to say that it possesses several new features this year, one would but be repeating an observation which is true of it every year. Speaking from the point of view of a scientific review we should welcome a little more attention to science, or to the scientific aspects of industry, among its able summaries. But one cannot expect everything within its covers; and the information which is given is remarkable for its usefulness, its universality, its just proportions, and its unblemished accuracy.

The Englishwoman's Year Book.—This is a publication which, like "Who's Who," is published by Messrs. A. & C. Black, and is gaining for itself with some rapidity the same position of indispensability. Nothing that concerns women, especially working women, is alien to it; and we can suggest no improvement beyond the addition of a more characteristic calendar. The calendars, we think, might well embrace the birthdays of famous women.

X-Ray and Electro-Physical Apparatus.—Mr. A. C. Cossor, of 54, Farringdon Road, has sent us a copy of his recently-issued list, covering the various specialities manufactured by him. Beyond X-ray and allied apparatus the catalogue comprises many articles of use or interest to the worker on the physical side of science. We are glad to notice that there are several scientifically trained assistants on the staff of the firm, the importance of which cannot be overrated where the requirements of modern science are to be successfully carried out.

XUM

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, F.R.M S.

Royal Microscopical Society.

NOVEMBER 16TH, Rt. Hon. Sir Ford North, F.R.S., in the chair. Mr. Rousselet described two old microscopes which had been presented to the Society by Mr. C. L. Curties. The first was a copy by Dollond of Cuff's "New Constructed Double Microscope," designed by Cuff in 1744, in which the body was moved instead of the stage, the latter being customary in microscopes of later date. The second microscope was a copy of "Jones' most improved compound microscope," made and modified by Banks, between 1811 and 1820, though the invention of this type dates from 1798. Mr. Hugh C. Ross, R.N., exhibited and described a new electric warm stage of his invention. It consisted of a flat plate or box of ebonite about 3 inches long, 1½ inches wide, and ⅜ inch thick. A coil of wire offering a standard resistance was pressed into the ebonite box and covered in with a sheet of mica. The ebonite box rested on the slide, mica side downwards, and a gap 1 inch square was left in the centre of the stage so as not to interfere with the examination of the object. A Nernst lamp served both as illuminant and regulator of the current to the warm stage. It was claimed that this warm stage, being used above the slide, did not interfere with the focus, could be used with the highest powers, allowed the use of a condenser, did not interfere with the movement of the mechanical stage, and was self-acting. Mr. C. L. Curties exhibited new designs of Nernst lamps suitable for use with the microscope for currents of 100 and 200 volts respectively, and fitted with ground or blue glass fronts. Mr. Conrady read a paper on "Theories of Microscopic Vision. A vindication of the Abbe Theory," which contained some new views on the subject.

The Quekett Microscopical Club.

The 417th Ordinary Meeting of the Quekett Microscopical Club was held on November 18th at 20, Hanover Square, W., the President, Dr. E. J. Spitta, V.P.R.A.S., in the chair. Mr. A. E. Smith exhibited a number of large transparencies, prepared from his own photo-micrographs. Notes by Mr. A. E. Merlin, F.R.M.S., "On a suggested modification of Rousselet's Live Box" and "A supplementary note on the foot of the House Fly" were, in the absence of the author, read by the Hon. Secretary. In the first note Mr. Merlin, after paying tribute to the manifold advantages of the Rousselet Live Box, alluded to the fact that the comparatively rapid evaporation of the water film prevented any prolonged observation of minute organisms such as monads, &c., under high powers. If, however, the cover-glass is cemented to the flange instead of being screwed in, and if a rubber band is slipped round the junction of the box and the carrier, a practically airtight joint is formed, and evaporation proceeds so slowly that he had been able to keep an object under observation for several days.

Mr. Merlin's second note was a continuation of two previous papers on the same subject read before the club in 1895 and 1897. He now reported that he had succeeded in detecting a small knob or protuberance on the side of the sickle-shaped terminal appendages of the hairs of the *pulvillus*, which knob, in his opinion, marked the position of the aperture through which the viscid secretion was poured out. He had not, however, been able as yet to detect the aperture with the highest optical power at his disposal, viz., $\frac{1}{8}$" apochromat by Zeiss of N.A. 1.427 and a 40 compensating ocular. Even with this magnification the image of the sickle filament was sharp and clear.

Mr. A. E. Conrady, F.R.A.S., F.R.M.S., then gave a *résumé* of his important paper "Theories of Microscopical Vision—a Vindication of the Abbe Theory," which had been read before the Royal Microscopical Society on the previous Wednesday.

Micro-photographs.

The term micro-photograph is used in England to distinguish minute photographic reductions of larger objects in contradistinction to photographs of enlargements of microscopic objects which have been magnified by means of the microscope, and which are known as photo-micrographs. In the "Photographic Reference Book" for 1904 an account is given of the method of preparing such micro-photographs, of which the following brief *résumé* may be of interest. They require considerable patience and skill, as the image is so minute that the operations of development, &c., must be carried out in the field of a magnifier or small microscope. Most of these photographs are made abroad, and the collodion process (wet plate) is used, or collodio-albumen may be employed. The collodion used for making the plates must be structureless or the magnified images will have a reticulated appearance. Pyrogallic acid is preferable to iron sulphate for development, as it gives a much finer deposit. The process consists in making a positive by copying an illuminated negative, using a one-inch microscopical objective for this purpose. Mr. Hislop has devised a suitable apparatus, which is described in Mr. Sutton's "Dictionary of Photography." It consists of a rigid mahogany board about six inches wide and three feet six inches long. At one end two uprights are fixed, between which a miniature camera, fitted with the microscopical objective, can be moved up and down so as to allow it to be placed opposite the negative to be copied. A brass tube projects from the camera towards the negative, to carry the objective, and is fitted with stops of different sizes. The exact focus must be ascertained carefully by means of a strong magnifying glass. The negative is placed in a frame at the required distance on the long mahogany board. The illumination may be natural or artificial, but must, of course, pass through the negative, whilst the variations of light, negative, and plate, render it impossible to give any idea of exposure. It will generally be found that the visual and actinic foci do not coincide, and this must be determined by experiment and allowed for, so that a fine adjustment becomes necessary. After exposure the little plate is placed under a low power microscope, in yellow light, and a few drops of developer poured over it, development being carefully watched through the microscope, remembering that a transparency is required, and, therefore, greater density than otherwise should be obtained. After fixing and drying, and before mounting, the tiny plates should be

examined through a lens of about the same power as they are intended to be viewed through, in order to see whether they are worth proceeding with. The photographs are then cut into small squares with a diamond, and can be mounted direct on to slides of the ordinary form or to the flat end of the small Stanhope lenses, to which they are generally attached. The slide or the Stanhope lens must be warmed, and the mounting medium is Canada balsam. Care must be taken that the contact is perfect, and that the slide is free from either air-bubbles or dust.

New Regulator for Cambridge Embedding-Bath.

The Cambridge Scientific Instrument Co. have brought out a new regulator for their well-known and most convenient embedding-bath, which does away with the former mercury regulator with its failings. The new regulator was primarily designed to utilize an ordinary paraffin lamp, where gas is not available. The hot air travelling up a short chimney heats the water in the bath. Suspended over the chimney by a lever is a plate of brass serving as a sort of lid. This lever is in contact with a bar of aluminium which is enclosed inside the bath, and is stayed between similar bars of nickel steel in such a way that it can only move laterally, and in so moving raise or depress the

lever according to variations in temperature of the bath. Any such movement of the lever therefore alters the position of the lid, and consequently regulates the amount of heat transmitted to the bath. Provision is made for the primary adjustments. Though originally arranged for a lamp (as illustrated) I think it would be equally effective with a small burner, and I believe the makers have adapted it accordingly.

I would like to call attention to the fact that the Cambridge Scientific Instrument Co. have just reduced the price of the improved 1900 model of their well-known Rocking Microtome to £3 15s., and have withdrawn the older model altogether. For cutting serial paraffin sections this microtome has now a European reputation, and needs no recommendation. It is in use in probably every large English laboratory, and the reduction in price should largely increase its use by all classes of workers.

Journal of the Quekett Club.

The half-yearly issue of the *Journal of Quekett Microscopical Club*, dated November last, contains the following papers :—" The Genital Organs of *Taenia sinuosa*," by Mr. T. B. Rosseter (illustrated); " Some New Sense Organs in Diptera," by Mr. W. Wesche (illustrated); the description of two new British Water-mites, by Mr. C. D. Soar, and a list of the Spiders of the *Erigone* group, by Mr. F. P. Smith. None of these papers lend themselves to review, but the Proceedings of the Club contain a *résumé* of an interesting lecture by Dr. E. J. Spitta on suiting screens for photo-micrography of stained bacteria in order to increase contrast, with reference to the value of the light for photographic rather than visual purposes. Dr. Spitta had tested by means of a spectroscope the behaviour of various orthochromatic plates to light of different wave-lengths, and his paper is illustrated by a plate showing the result, which deserves careful study by photo-micrographers.

Notes and Queries.

Mounting Volvox, Larvæ of Water Insects, &c.

Mr. F. T. Perks, of Denmark Hill, would be glad to know if there is any method of mounting Volvox, Larvæ, &c., so as to preserve their natural colour. The ordinary methods of mounting certainly fail to do this, and most zoologists would either examine the objects alive or stain them in such a way as to bring out some special feature. So far as the larvæ are concerned I think they might be narcotized by cocaine, then killed with a ¼ per cent. solution of osmic acid, and mounted in 2½ per cent. solution of formalin according to Mr. Rousselet's method for Rotifera, but I could not say whether this would prove practicable with Volvox, which is a particularly difficult object to mount satisfactorily so as to show all the structure. Full particulars of Mr. Rousselet's methods have been frequently published; there is a very full account in Cross and Cole's " Modern Microscopy." Perhaps Mr. Perks will let me know the result of his experiments, or I should be glad of suggestions from other readers.

Use of the Petrological Microscope.

Mr. J. F. K. Green wishes to know of a book dealing with the use of the petrological microscope. There is unfortunately no book dealing with the subject from the microscopic standpoint, even the largest works being strangely silent on the matter. In the "Annual of Microscopy" for 1900 I endeavoured to deal with the fundamental principles of the subject in an article entitled "The Practical Applications of the Polarizing Microscope," to which I may perhaps refer my correspondent if he requires a brief *résumé* of the subject. For further information he might read Groth's " Physikalische Krystallographie," or Dana's " Textbook of Mineralogy," or Rutley's " Study of Rocks," and Cole's " Practical Geology," which deal with the petrological and geological side, and incidentally touch on the microscopical methods. I must warn him, however, that the subject is one that requires study if it is to be of practical service in petrology or crystallography.

Echinus Spines.

Rev. W. Hamilton Gordon, Fareham.—Mr. Alfred Death, of Bury St. Edmunds, who kindly sent me the spines, informs me that they are *Echinus sphæra*, and that he found several of them on the coast at St. Osyth, a village between Clacton-on-Sea and Brightlingsea.

[*Communications and enquiries on Microscopical matters are invited, and should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for January.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 8.8, and sets at 4.0; on the 31st he rises at 7.42, and sets at 4.45.

The earth is nearest the Sun on the 1st at 5 a.m., hence he attains his maximum apparent diameter of 32′ 35″.

Sunspots, faculæ, and prominences are very numerous; at the time of writing there are several fine groups of spots almost stretching from limb to limb, which define the spot zone most conspicuously.

For plotting the positions of spots, &c., the following table may be used :—

Date.	Axis inclined from N. point.	Equator N. of Centre of disc.
Jan. 1 ..	2° 1′ E.	3° 13′
,, 11 ..	2° 52′ W.	4° 19′
,, 21 ..	7° 33′ W.	5° 17′
,, 31 ..	11° 55′ W.	6° 4′

THE MOON :—

Date.	Phases.	H. M.
Jan. 5 ..	● New Moon	6 17 p.m.
,, 13 ..	☽ First Quarter	8 11 p.m.
,, 21 ..	○ Full Moon	7 14 a.m.
,, 28 ..	☾ Last Quarter	0 20 a.m.

OCCULTATIONS.—The following occultations of the brighter stars are visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance.			Reappearance.		
			Mean Time.	Angle from N. point.	Angle from Vertex.	Mean Time.	Angle from N. point.	Angle from Vertex.
			p.m.			p.m.		
Jan. 10..	ϕ Aquarii	4·4	5·9	45°	31°	6.23	265°	240°
,, 17..	B.A.C. 1526 ..	5·8	9.40	37°	28°	10.36	306°	284°
,, 18..	130 Tauri.. ..	5·5	5·58	103°	142°	7.1	240°	276°
,, 19..	26 Geminorum ..	5·1	4·51	140°	180°	5.24	213°	254°
			a.m.			a.m.		
,, 24..	β Virginius ..	3·8	0.43	145°	174°	1.40	260°	281°

THE PLANETS :—Mercury.—Towards the end of the month Mercury is a morning star in Sagittarius, being at greatest elongation of 24° 28′ W. on the 22nd, when he rises at 6.24 a.m.

Venus is the most conspicuous object in the evening sky looking towards the S.W., and sets about 4 hours after the sun. The planet is increasing in brilliancy, and can readily be seen when on the meridian in broad daylight; the time of meridian passage is 3.5 p.m. and is very nearly the same on each day of the month, whilst the meridian altitude increases from 23° on the 1st to 37½° on the 31st. The apparent diameter of the planet on the 15th is 18″·2; the disc appears slightly gibbous, 0·65 being illuminated.

Mars does not rise until after midnight.

Jupiter is on the meridian shortly after sunset, and remains above the horizon until midnight. In consequence of increasing distance from the earth, the planet is diminishing in lustre; the apparent equatorial diameter is 40″·5 on the 16th, whilst the polar diameter is 2″·6 smaller. The planet is in quadrature on the 12th.

The following table gives the phenomena of the satellites visible in this country.

Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
2	II.	Ec. R.	6 13	13	I.	Oc. D.	7 1	22	I.	Ec. R.	6 57
4	I.	Oc. D.	10 37		III.	Tr. I.	8 52	23	II.	Oc. D.	8 57
5	I.	Tr. I.	7 45		I.	Ec. R.	10 32	24	III.	Ec. D.	8 41
	I.	Sh. I.	9 6		III.	Tr. E.	11 6		III.	Ec. R.	10 12
	I.	Tr. E.	9 59	14	I.	Sh. I.	5 31	25	II.	Tr. E.	6 41
	I.	Sh. E.	11 18		I.	Tr. E.	6 23		II.	Sh. I.	6 49
6	I.	Oc. D.	5 5		I.	Sh. E.	7 43		II.	Sh. E.	9 18
	III.	Tr. E.	7 5	16	II.	Oc. D.	6 18	28	I.	Tr. I.	8 3
	I.	Ec. R.	8 37		II.	Oc. R.	8 50		I.	Sh. I.	9 22
	III.	Sh. I.	10 29		II.	Ec. D.	9 3		I.	Tr. E.	10 17
7	I.	Sh. E.	5 47	17	III.	Ec. R.	6 11	29	I.	Ec. R.	8 53
	II.	Tr. I.	9 29	18	II.	Sh. E.	6 40	30	I.	Sh. E.	6 3
9	II.	Oc. R.	6 13	20	I.	Oc. D.	8 57	31	III.	Oc. D.	7 8
	II.	Ec. D.	6 26	21	I.	Tr. I.	6 6		III.	Oc. R.	9 24
	II.	Ec. R.	8 50		I.	Sh. I.	7 26				
12	I.	Tr. I.	9 40		I.	Tr. E.	8 19				
	I.	Sh. I.	11 2		I.	Sh. E.	9 39				

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its re-appearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress.

Saturn is diminishing in brightness, and is only observable for a short time in the S.W. after sunset. The plane of the ring is inclined to our line of vision at an angle of 14°; hence the ring appears well open.

Uranus is unobservable.

Neptune souths at 11.45 p.m. on the 1st and at 9.44 on the 31st. He is situated in the constellation Gemini and can readily be found by reference to μ Geminorum.

	Right Ascension.	N. Declination.
Neptune (Jan 14) .	$6^h\ 27^m\ 19^s$ ..	22° 16′ 33″
μ Geminorum . .	$6^h\ 17^m\ 13^s$ ..	22° 33′ 36″

METEOR SHOWERS :—

Jan. 2-3	XV.h 20m	+ 53	Quadrantids	Swift; long paths.
,, 17	XIX.h 4m	+ 53	θ Cygnids	Slow; bright.

THE STARS :—

Minima of Algol occur between sunset and midnight on the 13th at 10.37 p.m., 16th at 7.26 p.m., and 19th at 4.14 p.m.

o Ceti (Mira) should be watched, as it will probably reach a maximum next month, when observation will be difficult on account of daylight.

TELESCOPIC OBJECTS :—

Nebulæ.—Orion Nebula, situated in the sword of Orion, and surrounding the multiple star θ, is the finest of all nebulæ; with a 3 or 4 inch telescope, it is best observed when low powers are employed.

Crab Nebula (M 1), in Taurus, situated about 1½° north-west of ζ Tauri in R.A. 5h. 29m., Dec. 21° 58′ N.

Clusters.—M 37, situated in Auriga, is one of the finest clusters, and very compact; its position is R.A. 5h. 46m., Dec. 32° 32′ N.

DOUBLE STARS.—β Orionis (Rigel), mags. 1 and 9. separation 9″. On account of the brightness of the principal star, this double is a fair test for a good object-glass of about 3-inch aperture.

δ Orionis, mags. 2 and 7, separation 53″; easy double.

ζ Orionis, triple, mags. 3, 6, and 10, separation 2‴·5 and 56″; rather difficult in a 3-inch telescope.

λ Orionis, mags. 4 and 6, separation 4″·5; pretty double.

σ Orionis, triple, mags. 4, 8, and 7, separation 12″·5 and 42″.

XUM